

# **Technology and Innovation in an Emerging Senior/Boomer Marketplace**

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## Executive Summary

There are those who describe the expected impact of a large aging population as a “crisis.” Some community, business, academic, and government leaders, however, view aging demographics as an “opportunity.” The potential benefits of this opportunity will not be realized, however, without unleashing this nation’s innovative and entrepreneurial spirit to create and deliver technology that responds to the “quality of life” needs of older Americans.

In the past, technologies associated with aging were generally applied to disease or disability. Today, however, aging demographics and Baby Boomer lifestyles seem to be calling for a different kind of technology. The approaching wave of wealthier, healthier and more independent Boomers is reframing the discussion of technology needs. In response, technology and public policy will reflect greater emphasis on extending independence, productivity, and quality of life for the nation’s senior citizens.

Because Boomers are themselves largely responsible for the successful development and widespread use of technology in our society, they can be expected to continue to be technology savvy consumers as they grow older. Because Boomers are more “connected” than previous generations, technology awareness and adoption may be less of an issue than keeping abreast of the latest developments and being trained in technology products that best suit their needs and those of their caregivers and employers. Boomers may also be more discriminating and demanding of technology, driving companies to produce more “user centric” products with greater focus on usability, usefulness, and use. Increasing emphasis on “Universal Design” and human factors or ergonomic engineering and design should also assure that user’s needs and characteristics are included early in the innovation life cycle.

This paper has been prepared as background for discussion of technology at the 2005 White House Conference on Aging. Those discussions are expected to reinforce the notion that technology research and innovation should not be limited to aging per se but should include what would be needed to maintain or improve every American’s “quality of life.” Although translating quality of life into technology research, innovation, and policy priorities would be subjective, it will serve as the underlying theme to any discussion concerning an aging Boomer population.

Although aging-related technology is not yet recognized as a distinct industry or product category, six major applications have been identified for which technology can contribute to independence, health and productivity: living environment, mobility, healthcare, cognition, employment, and connecting with their community, caregivers and the nation’s healthcare system. In recent years, the nation’s research community has begun recognizing these needs, which has led to aging-related technology study, research, and product development.

Research at some of the nation's leading universities has shown that independence can be supported by introducing technology into an individual home or assisted living facility. For example, sensors can detect a lack of activity or changes in a person's gait and can then alert medical providers and caregivers to a possible illness or emergency. Builders are working with architects and product developers schooled in the needs and limitations of aging persons to enhance independence and safety through design and technology. "Smart" appliances will assist the older resident in the kitchen while robots and personal devices will assist with many of the daily living and caregiving functions as well as provide companionship. These early-stage technologies are already beginning to reach the retail market, but widespread adoption may depend on greater awareness, adoption, and, for some, financial assistance.

Continued mobility is essential to an aging person's independence, identity, and feelings of self worth. New applications for the driver, the vehicle, and the road will enable elderly individuals to continue driving safely. Technology will touch every other mode of mobility as well, from smart walkers and wheelchairs to public transportation and pedestrian infrastructure. Federal agencies, academic researchers, and the transportation and personal mobility industries are already working together to identify and address mobility needs.

Until now, the focus of healthcare technology has been injury, disease, and disability. As the ranks of America's aging swell, those needs will likely increase. Aging in place, preventive medicine, strength and fitness, and slowing (or reversing) the effects of aging will, however, create a quite different market for technology, and, together with incentives for disease management and prevention, should encourage demand for innovative products and services.

For an aging population, healthy minds are as important as healthy bodies. It is in the areas of brain/cognitive science and brain/computer interface that the convergence of science and emerging technologies may have the greatest impact on quality of life, and provide the greatest challenges to policy-makers and ethicists. Researchers believe that new devices that assist memory, stimulate or manage other brain functions, stimulate or replace nerves, muscles, organs and limbs will help slow, reverse, or overcome the effects of cognitive disease and disability regardless of age. What would have been science fiction a few years ago may become the key to quality of life in the near future.

The impact of the Boomer wave on the nation's workforce will be another familiar topic at this Conference. To remain competitive and to provide for their own economic security over a longer lifespan, aging Americans will be expected to contribute their knowledge, skills, and experience for additional years in the workplace. Technologies to assist them will likely include more accessible information technology software and hardware, communications aids, and portable offices.

Being "connected," whether to one's family, caregivers, community, institutions, or healthcare system, is one of the more important quality of life needs, and aging Americans will be increasingly connected by such technologies as the Internet, wireless devices, and telemedicine. They will also want to manage their own health by remotely accessing electronic medical records, much like they currently access their bank accounts and travel plans on-line. As aging in place becomes the preferred lifestyle and a lower cost alternative to institutionalization, experts expect remote monitoring, intervention, and treatment of aging



parents and patients to enhance connectivity, increase healthcare productivity, and ease caregiver stress.

Technology solutions are not without their challenges, however. Ageism and stereotypes must be addressed with accurate information, the promotion of positive attitudes, and enforcement in some cases. The movement toward remote monitoring and electronic health records is expected to be accompanied by a lively discussion of privacy and security. Technologies that stimulate cognition and replace or enhance natural functions may be challenged on ethical or religious grounds. The additional challenges of 75 million older drivers, an aging workforce, and caregiver stress have yet to be fully understood.

A patchwork of federal, state and local policies, regulations, standards, and codes, many established before today's technologies were envisioned, can be barriers to innovation. Federal, state and local regulation of nursing homes and assisted living facilities, for example, requires technology firms to understand, conform to, and comply with several layers of regulations and codes that may differ by state, county, and even municipality. The set of definitions that different agencies apply to regulate devices may not be well understood by innovators or may vary significantly from agency to agency. Procurement policies and regulations may act as yet another obstacle to small- and medium-sized firms that do not have the financial depth for long regulatory processes. The cost of conforming and complying will likely be passed along to an already expensive healthcare system. A broad coalition of public and private partners would be needed to effectively respond to these issues leading to a more efficient marketplace for aging-related technology.

Until now, aging-related technology has not been recognized as a distinct industry or sector. Surveying technology companies engaged in innovating aging-related products and services to identify barriers to innovation and growth would be an important first step, and an industry or trade association to represent the interests of aging-related products and services firms is clearly needed to respond to the broad range of stakeholders. A true industry association representing the many different fields of aging-related technology would also be expected to advance public and private policies and strategies to strengthen the industry's growth, innovation, and competitiveness.

Public policy should also be concerned with assuring those firms are competitive in what is likely to be a very large and rapidly growing global market. Even though the United States has a competitive edge in technology and innovation in general, we should not assume that we lead the world in aging-related innovation. To fully profit from our innovation advantage, comprehensive surveys or studies that provide useful data on this nation's aging-related technology producers, products and services, their competitive strengths and weaknesses, their international market potential, and what other nations are doing to develop competitive industries are needed. Further definition, classification, and the creation of North American Industry Classification Systems (NAICS) codes specific to aging-related technology products would also be an important corollary to any data collection effort.

There is evidence that Boomers will be more able and willing to pay for products that support independence and quality of life, and will, therefore, demand technology that has been proven to maintain or improve quality of life. Because the concept of aging-related technology is still fairly new and the wave of retiring Boomers is still just over the horizon,

the opportunity to develop business models, incentives, public policy, and consumer expectations that differentiate aging-related technology from those for which third party reimbursement is obligatory is very timely.

In addition to attending to the more traditional policy priorities (e.g. access, equity, privacy, security, etc.), policy-makers must address how to best stimulate research, innovation, investment, awareness, acceptance, and adoption. Additional and more effective use of available research funding is one approach. The diversity of many different federal, university, and private sector research programs suggests the need for greater coordination and prioritization to assure we achieve our desired outcomes and properly distribute our resources and efforts. The same diversity underscores the importance of developing quality and performance standards. Emphasis on leveraging resources and technology transfer and commercialization should lead to greater interest in public/private partnerships.

There are some leading thinkers who take the view that a crisis is looming as Boomers move into retirement and previous generations age further. While a sense of urgency among various stakeholders may not be currently apparent, the agenda of this Conference evidences nearly universal concern. A national strategy that enables technology to improve quality of life for all ages must address the extensive variety of individual, economic and social needs for an equally diverse range of stakeholders. To resolve these issues for the benefit of all Americans it is important to assure that key stakeholders are engaged in continuing technology policy discussions supported by the very best research and analysis.

## Introduction

This paper has been prepared for the 2005 White House Conference on Aging (WHCOA), convened every ten years to make aging policy recommendations to the President and Congress, and to assist the public and private sectors in promoting the dignity, health, independence, and economic security of current and future generations of older persons. This year's Conference is especially significant because a large number of "Baby Boomers" will begin retiring in a few years is expected to significantly impact nearly every facet of American society. Because the rapid growth and adoption of technology paralleled and, in many respects, defined the Boomer generation, it is important to discuss how technology and public policy can continue to serve our national interests by advancing the dignity, health, independence, productivity, and economic security of Boomers, parents and grandparents.

The primary objective of this paper is to present the case for recognizing aging-related technology in order to focus the attention of a wide range of stakeholders on its potential for enhancing the quality of life for the nation's older citizens. In doing so, the paper discusses:

- what aging-related technology is, and how it differs from and relates to healthcare and assistive technologies;
- current and future needs;
- the current state of research, innovation, and product development;
- what is needed to support innovation;
- the global outlook for and competitiveness of U.S. technology; and
- barriers to innovation, demand, and investment.

This paper does not intend to recommend policy or program solutions because the subject is relatively new, and more research about what is needed and how the market will respond is required. Additional research and discussion directed at specific needs and barriers would be an appropriate role for the public and private partnership emerging from this Conference.

## Aging Demographics

Although the demographics of America's aging population are well known, to be consistent with the White House Conference on Aging, we will refer to Americans age 60 and above as the nation's aging. The Conference also especially recognizes the next wave of America's aging population, the "Baby Boomers," comprised of about 76 million people born between 1946 and 1964. The Boomers are sometimes divided into two groups – the "early Boomers" born between 1946 and 1954, and "late Boomers" born between 1955 and 1964. For the purposes of this report, we will also refer to those who have retired or are about to retire but who are, for the most part, still living independently, ages 60-79 as "Mature Seniors." A third segment is those aged 80 and above is commonly referred to as the "Oldest Old,"<sup>1</sup> the fastest growing group among the elderly.

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<sup>1</sup> Another term frequently used for this "cohort" is the "frail elderly." According to Dr. William Mann of the University of Florida, there has been considerable discussion of the term "frailty" in the medical literature in the

## Defining Aging-Related Technology

Although America's older generations have been technology users and consumers for a generation or two, technology designed for an aging population has not been recognized as a distinct product category or "industry sector." Defining what we mean by aging-related technology is necessary, then, for examining needs, response, and outlook.

For the purpose of this report, aging-related technology includes products and services that enable persons to perform tasks or functions at a level similar to an earlier experience, and/or contribute to a lifestyle of independence. Products or services that do not support tasks or functions (such as anti-aging creams and dietary supplements) are not included in this discussion.

How does aging-related technology compare with "assistive" technology? The definition of assistive technology is similar: "products that enable persons (regardless of age) to perform a function that would otherwise be difficult due to some disability." While some disabilities are associated with aging, aging is not a disability. To be considered an aging-related technology, the product or service should relate to a function or ability lost over time as a result of aging.

Although closely related, aging-related technology should also be considered separately from healthcare technology. While the aging population is concerned with healthcare, aging-related technology is not necessarily designed for a specific health issue. This is a new category of technology that has not yet been widely recognized.

The Center for Aging Services Technologies or "CAST," a coalition of more than 400 companies, universities, health care providers and government entities organized to explore ways technology could help seniors, further defines aging-related technologies as:

1. Enabling technologies (assists persons to "age in place")
2. Operational technologies (assists aging persons to function in society)
3. Connective technologies (assists aging persons to communicate with caregivers, families and medical resources and vice versa)
4. Telemedicine (allows a medical source or caregiver to monitor, diagnose and/or treat patients from a distance)

Note that each category describes functions that may apply less to persons of a certain age than to "quality of life" and independence regardless of age.

Because the concept of technology for an aging population is so new, its definition will likely continue to evolve. There is a school of thought that resists defining or singling out any technology as applicable only to aging. The same school urges innovators, investors and producers to expand their definition to focus on quality of life rather than aging. The reasons for this distinction are twofold:

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past 5 years. Clearly, there are many people over age 80 who are not frail. Conversely, an individual could be frail at virtually any age, and there are many 60 and 70 year olds who are frail.

1. Generalizing about aging needs is difficult because of the wide range of ages, abilities and preferences
2. A negative association with the term “aging” (or similar terms) drives away innovators, investors and consumers

These reasons may be more relevant to the Boomers who are seen as resisting labels and stereotypes that imply a limitation or dependency. One of the most significant impacts of the Boomer generation, then, may be to relate technology not specifically to aging but more generally to independence and an independent lifestyle.

## Technology Needs of an Aging Population

Given the demographics of America's aging population (45 million people age 60 and over plus another 76 million Boomers), its projected purchasing power (as much as \$2 trillion per year), and its influence in every sector of society, aging-related needs will become a primary focus of economic, commercial, social, and technology discussion and policy over the next decade.

Because their parents have benefited from greater financial security, better health and increased longevity, the Boomer generation has been able to observe what will be most at risk as they age: health, independence, mobility, financial security, social engagement, and cognition. Their observations will determine their expectations and perceived needs for technology as they prepare themselves to retire, age and, for some, become caregivers themselves.

One difficulty in discussing needs for an aging population is related to common references to subsets or aging "cohorts" that may have very different needs. Because they represent the younger range of the nation's aging population, Boomers are generally considered healthier,<sup>2</sup> more mobile, more affluent, and more active than their parents and grandparents. Recent surveys indicate, for example, that the majority of Boomers will choose to continue working longer.<sup>3</sup> Technology needs, then, will include devices and products to maintain workplace participation and productivity. National trends of teleworking and home-based businesses will converge with the concept of "aging in place" to drive demand for home or mobile technologies. Boomers will begin to retire in the next few years, however, so their demand for technology and its impact on the nation's aging services has yet to be fully understood.

Many needs of older adults are amenable to technological solutions. What has been lacking to date is a coherent and parallel effort to understand these needs and to apply expertise to design solutions and successfully bring them to market.

Another factor related to the needs of the elderly is how aging consumers accept and adopt new technologies. One multi-disciplinary study suggested the following as factors that could affect the acceptance of new technologies by the elderly: "access, cohorts, culture and language, customization, expectations, legal constraints, stereotyping, privacy, safety, training, trust, usability, and control, autonomy, and dignity."<sup>4</sup> These factors can, in some cases, also be viewed as barriers.

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<sup>2</sup> Absolute growth in the number of seniors equals absolute growth in the number of chronic disease sufferers. Relative growth, however, tells a different story: The percent of those aged 65 and older experiencing disability and resulting dependency is down by 1% or more per year for the past several decades. This encouraging statistic suggests a healthier, more independent aging population well into the future.

<sup>3</sup> "America's Aging Workforce Posing New Opportunities and Challenges for Companies to Utilize Mature Employees" based on a report released by the Conference Board September 19, 2005 at [http://www.conference-board.org/utilities/pressDetail.cfm?press\\_ID=2709](http://www.conference-board.org/utilities/pressDetail.cfm?press_ID=2709)

<sup>4</sup> Ibid.

The notion that older persons cannot or will not adopt technologies is changing. The Association for Advancement of Retired Persons (AARP), the largest organization for aging Americans, reports that in 2004, 60% of its membership was regularly online, up from 46% in 2002.<sup>5</sup> This trend can be expected to continue and, perhaps, accelerate as older persons are provided with adequate training and realize the benefits of technology.

Electronically connected seniors are more likely than younger users to send and read eMail (94% vs. 91% for all Internet users) and more likely to obtain health information online (66% for Mature Seniors and 70% for Boomers versus 56% of users age 18-29). Half of all online Boomers seek financial information over the Internet versus 31% of younger computer users.<sup>6</sup> These are but a few examples pointing to the likelihood that those “Boomers” who are technologically savvy will continue to accept technology as they age.

Does the dramatically changing marketplace make it necessary to rethink how technology needs and demand are considered, researched and calculated? Will innovation, product development, and the availability of aging technology reflect interrelated lifestyle, employment, healthcare, caregiving, communications, and cognition needs? These are difficult but important questions that must be revisited over time as those needs change.

## **Lifestyle**

There is a common assumption that lifestyle choices of America’s aging will change dramatically from the WWII generation to the Boomer generation. One writer asks:

“...will the elderly of 2025--who grew up in an age of affluence, fought in Vietnam, and spent midlife in an era of "downsizing"--really be the same as today's elderly--who grew up in the Great Depression, fought in World War II, and retired in a time of relative security?”<sup>7</sup>

Whereas Boomers often associate “assisted living” with their parents’ lifestyle and experiences, it is widely believed that Boomers will view “independence” differently than their parents. Their relationship with their families and communities will entail a longer lifespan, a quality of life indicator we might call “lifelong engagement.”

## **Home Environment**

The home or assisted living quarters is where “independent living” and “aging in place” happen. With modifications, practically any home environment can help maintain functions and independence important to an individual’s quality of life. The Rehabilitation Engineering Research Center for Successful Aging at the University of Florida has identified eight levels on a continuum of functions that would be expected from technology interventions:<sup>8</sup>

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<sup>5</sup> It is worth noting that the AARP survey may not be representative of the nation’s older population. Representative studies of computer and Internet use (e.g., Pew, UCLA, Bureau of Labor Statistics) show that only about 30% of those households headed by someone age 65 and above report being online.

<sup>6</sup> “Older Americans and the Internet,” Pew Internet and American Life Project Report at: [http://www.pewinternet.org/PPF/r/117/report\\_display.asp](http://www.pewinternet.org/PPF/r/117/report_display.asp)

<sup>7</sup> Morgan, David L., “The Aging of the Baby Boom,” *Generations* (the journal of the American Society on Aging), Volume XXII, 2000, No. 4

<sup>8</sup> From “Smart Technology for Aging, Disability, and Independence – The State of the Science,” edited by RERC Director William C. Mann, Ph.D., Wiley-Interscience, 2005

1. Offer basic communications
2. Respond to simple control commands from within or outside the home
3. Automate household functions
4. Track an individual's location in the home, his or her behavior, and his or her health indicators
5. Analyze data, make decisions, take actions
6. Provide information, reminders and prompts for basic daily tasks
7. Answer questions
8. Make household arrangements

This brief description of technology interventions effectively summarizes what will be required to maintain quality of life for an aging population.

### **Independent Living**

“Independent living” is often used to describe a type of housing designed for persons who do not require extensive personal or medical care but who choose to live away from their homes, such as senior apartments or retirement communities.

In 2003, the National Academies of Science (NAS) organized a notable workshop of experts in a variety of age-related subjects to discuss “Technology for Adaptive Aging.” In its session on “The Impact of Technology on Living Environments for Older Adults,” workshop participants reported:

Functional changes in their abilities often motivate older people to choose environments in which more assistance is available. As in the health domain, in-home monitoring and assistive technologies to support independent living are of great interest. Specific technologies include various types of reminder systems to support the independence of those with memory impairment or other cognitive deficits, and systems to monitor biological and other activity that raise both privacy and data reduction issues. Social communication aids include regularly updated profiles of the older adult's status on various monitored variables, which are represented visually in the caregiver's environment. The challenges to developing successful technology in this area include cost, ease of use, reliability, and privacy.<sup>9</sup>

Because technology applied to the independent living environment is generally specified by the institution, it will be necessary for consumers and caregivers to understand the older person's needs in order to make informed choices. As one researcher points out, “Leaders in the retirement housing industry recognize that they will have a big problem adapting their old approach to a new population of aging Boomers. Some have already developed successful models that link retirement living with lifelong learning. But much more imagination is needed is to develop models that will appeal to the next generation of older people.”<sup>10</sup>

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<sup>9</sup> “Technology for Adaptive Aging,” Board on Behavioral, Cognitive, and Sensory Sciences and Education of the National Academies of Science, 2004, Page 3. This document should be viewed as one of the early and most comprehensive discussion of technology responses to aging population needs.

<sup>10</sup>Moody, Harry R., PhD, “Silver Industries and the New Aging Enterprise,” *Generations*, Winter 2004-05, pp. 62-63



In addition to the challenge of understanding Boomers as significantly different from older generations of consumers, independent living providers will also be driven to lower operating and healthcare costs and will look to technology for help.

### **Aging in Place**

“Aging in Place” generally refers to the idea of the aging person remaining in his or her home rather than in another setting. A growing number of universities and non-profit organizations are investigating aging in place models where technology is embedded in an individual’s home to assist with routine functions.

One currently popular model is the “smart home” which contains a range of electronic technologies, aids, sensors, and devices that enhance functionality, convenience, safety and comfort. The Rehabilitation Engineering Research Center for Successful Aging funded by the Department of Education’s National Institute on Disability and Rehabilitation Research is experimenting with a variety of systems and devices in a fully furnished “assistive environment” that acts as a laboratory for testing interoperability and a “systems approach” to human factors engineering.

The Aware Home Research Initiative (AHRI) is, according to their Web site, an “interdisciplinary research endeavor at the Georgia Institute of Technology that addresses challenges facing the future of domestic technologies. It includes the Georgia Tech Broadband Institute Residential Laboratory, a three-story, 5040 square foot home that functions as a living laboratory for interdisciplinary design, development and evaluation.”<sup>11</sup>

The University of Virginia’s Medical Automation Research Center has developed a “Smart In-Home Monitoring System” which allows medical providers and caregivers to remotely monitor health and activity levels, well-being, and to measure decline in abilities over time. These observations may reveal early indicators of the onset of a disease, or alert caregivers to an unexpected change in activity (or inactivity) which can indicate an accident.<sup>12</sup>

The most popular and cost effective model is where the individual remains in his or her own home, and adds, adapts, or retrofits “off-the-shelf” technologies that improve safety and accessibility as they become known or available. Widespread adoption of this model has not happened, however, due to limited awareness of the availability and the high cost of home modifications as well as a stigma sometimes associated with what are viewed as disability aids. As a result, consumers are not yet demanding modifications in sufficient numbers to command the attention of policymakers, manufacturers, retailers, and remodelers. This may be related to the assumption that mature persons consider their home to be one of their most personal and private possessions, and do not want government or other interests to be involved.

### **Mobility**

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<sup>11</sup> For information on Georgia Tech’s AWARE project, visit: <http://www.cc.gatech.edu/fce/ahri/projects/index.html>

<sup>12</sup> For information on Virginia’s system, visit: [http://marc.med.virginia.edu/projects\\_smarthomemonitor.html](http://marc.med.virginia.edu/projects_smarthomemonitor.html)

Because the United States is a mobile society, independent living and aging in place must rely on continued access to available modes of transportation, to include driving, public transportation, and a user-friendly public infrastructure.

## **Driving**

Research indicates that aging persons do not stop driving until required to do so by others or as a result of some significant event. In a study focusing on transportation needs of New York's aging Boomers, researcher Nina Glasgow reported: "Driving is an important part of many older individuals' self-concept in much the same way that driving is a right of passage for younger people. To older people, driving symbolizes freedom, independence and competence."<sup>13</sup> Accommodating older drivers may require assistance from technology, such as automobiles that provide the driver or remote caregiver information on the vehicle and driver's location, speed, health, and vital signs. The vehicle may also be equipped with medical, monitoring, sitting, entry/exit, visual, and communication devices and technology to meet the elderly driver's needs.

The NAS report said about driving:

The special characteristics and needs of older drivers include behavioral, cognitive, and sensory changes that can affect their behavior and their ability to use technology effectively. Adaptive technologies include vehicle control devices, like adaptive cruise control, rear-view cameras, and backup proximity warnings; driving assistance devices, such as navigation and traffic information systems; and "infotainment" and comfort devices, including entertainment, Internet access, and communications systems. Technology developed for use in the automobile should be designed to be appropriate to the needs of the drivers. The issues include physical, visual, auditory, and cognitive design, as well as design of the driving environment; examples abound of unintended bad outcomes of well-intentioned but poorly designed and tested technology. Driver training could be required to ensure that new technologies are used properly and return the intended benefits.<sup>14</sup>

The National Highway Transportation Safety Administration develops strategies to improve safe mobility for older drivers, including the testing of driver evaluation tools and the evaluation of driver rehabilitation options.

In the private sector, auto industry leaders, such as Toyota, Nissan, Volkswagen, Ford, DaimlerChrysler and Fiat are working with researchers from MIT's Department of Aeronautics and Astronautics, Harvard Medical School, Ben Gurion University in Israel, MIT's Department of Electrical Engineering and Computer Science, and MIT's AgeLab on the design integration of intelligent transportation systems and lifelong safe driving.

## **Personal Transportation**

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<sup>13</sup> "The Transportation Mobility of New York's Aging Baby Boomers," a paper by Nina Glasgow, Ph.D, of Cornell University, included in Project 2015: The Future of Aging in New York State

<sup>14</sup> "Technology for Adaptive Aging," Board on Behavioral, Cognitive, and Sensory Sciences and Education of the National Academies of Science, 2004, Page 4

Common conceptions of personal mobility aids are walkers and wheelchairs. Both have gone “high tech” in recent years, such as the University of Virginia’s Medical Automation Research Center’s “robotic walker”<sup>15</sup> and Johnson and Johnson’s “iBot Mobility System” that will allow the user to “power across sand, gravel, grass and other uneven terrain, easily climb curbs and steps up to 5”, rise to an “eye-level” position, and hold a conversation, even on the move.”<sup>16</sup> Other products may assist with stair climbing, navigating steep grades or crowded places, standing, sitting, and preventing falls.

## **Public Transportation**

Aging persons will place additional demands on the nation’s air, rail, water, and public transit systems. Whereas access to public buildings, transportation, and facilities has been an important outcome of the Americans with Disabilities Act of 1990, now transportation planners must include the needs of many more older adults. To take the anxiety and uncertainty out of trip planning and transit use, increased emphasis should be placed on state-of-the-art information systems to improve awareness and usability of alternative services or services geared to older adults who are not officially disabled.

The Federal Transit Administration is conducting research to “improve services for low-income, elderly, and other transit-dependent travelers, including persons with disabilities, to improve access to jobs, educational opportunities, health care, and other essential activities.”<sup>17</sup> Increasing sophistication in personal mobility devices, such as the iBot and wheelchairs will likely spur urban planners to rethink pedestrian infrastructure in the United States.

Easter Seals has been a leading advocate of public transportation for aging and disabled populations. Its “Transportation Solutions for Caregivers” (TSC) funded by the Administration on Aging provides aging persons and caregivers Web-based sources for transportation alternatives. Easter Seals’ Project ACTION funded by the U.S. Department of Transportation, Federal Transportation Administration, has been working together with the transportation industry and disability community to improve access.

The University of Florida’s Neil Charness, researcher and author of “The Impact of Technology on Successful Aging,” is quick to point out, however, that unless society’s attitudes change, public transportation will continue to be the choice of last resort for most Americans, including older people.

## **Pedestrian Infrastructure**

Pedestrian mobility is one of the most basic requirements of an independent life style. Reduction in mobility due to physical frailty or psychological factors (such as fear of falling) leads to decreased quality of life and physical deterioration of the body. For seniors, the disinclination to travel by foot is often due to a pedestrian environment that can be

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<sup>15</sup> Read more about the intelligent walker and other University of Virginia innovations at their web site at: <http://marc.med.virginia.edu/projects.html>

<sup>16</sup> Read more about the iBot at: <http://www.independencenow.com/ibot/index.html>

<sup>17</sup> From the U.S. Department of Transportation’s Research, Development and Technology Plan for FY2005 which can be viewed at: <http://www.volpe.dot.gov/infosrc/strtplns/dot/rdtplan6/rdtplan6.pdf>

considered difficult if not unfriendly. Accessing local bus services, if available, may also be difficult if walking is required. And, as more aging persons use personal mobility aids to connect with the community and workplace, these and other characteristics of older pedestrians must be addressed.

Research has identified features that cause problems for pedestrians, particularly those with mobility difficulties, such as street crossings, fast and heavy traffic, narrow and uneven sidewalks, slopes, and steps.<sup>18</sup> Elements that can create safer environments for senior pedestrians include safe sidewalks, crosswalks, clear pedestrian signals, sufficient crossing time at intersections, benches for resting, reduced traffic speed, and traffic islands. Placing stores, services, and transit routes within walking distance of residential areas would also help serve older adults.

Pedestrian infrastructure should also accommodate the products and services that older persons depend on for mobility, such as wheelchairs, walkers, and robotic companions and caregivers, by providing, for example, secure device parking spaces, safe, accessible, and lighted crosswalks, and robot or battery charging stations.

## **Public Infrastructure**

Infrastructure for independent aging should include a supportive home, a productive workplace, effective personal communications, and mobility aids. Investments in public infrastructure will become essential to supporting aging technology (e.g. broadband for communication) and for meeting the accessibility needs of older Americans. Public infrastructure is an example of an instance where needs of the aging and persons with disabilities converge.

According to Dr. Joe Coughlin of MIT's AgeLab, infrastructure support will also be needed in other areas to "fully leverage advances in information, communications, nanotechnology, sensors, advanced materials, lighting, and many other technologies to optimize existing public and private investments and to create new environments that respond to an aging society's needs."<sup>19</sup> Although the nature of "new environments" can only be imagined, federal, state, and local governments should include the needs of a rapidly increasing aging population when considering current and future investment choices.

## **Employment**

Employment has very important social, economic, and technological implications for the aging population. Longer lifespan, healthier lifestyles, and new technologies are making employment possible for increasing numbers of mature seniors, and have given rise to such newly-minted terms as *delayed retirement*, *post-retirement employment*, and *unretirement*. Rand analyst Nicholas Maestas found that "nearly one-half of retirees follow a nontraditional

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<sup>18</sup> "Transportation Options: Keeping People Walking Safely for Local Mobility and Independence," ICADI 2003 Proceedings from the Web site: <http://icadi.phhp.ufl.edu/2003/presentation.php?PresID=202>

<sup>19</sup> "Technology and the Future of Aging," Joseph Coughlin, PhD, Journal of Rehabilitation Research and Development, Vol. 38, No. 1 (Supplement), January/February 2001, pp. S40–S42  
<http://www.vard.org/jour/01/38/1/sup/coughlin.pdf#search='joseph%20coughlin%20technology>

retirement path that involves partial retirement and/or unretirement.”<sup>20</sup> Continued employment of older workers will be necessary to offset slower growth in the U.S. labor force - expected to slow from an annual rate of 1.6 percent over the last 50 years to just 0.6 percent over the next 50 years. The number of workers aged 55 and older will grow, however, from 13 percent of the labor force in 2000 to 20 percent in 2020.<sup>21 22</sup>

Longer working Boomers will need new skills and technologies to remain employable. The National Bureau of Economic Research found that employees who remain current on technology and computer skills retire later than those who do not use computers.<sup>23</sup> The NAS report agrees: “Technology can help older workers remain employed and maintain or upgrade their skills, as well as support the transition to retirement through adaptive interfaces, software to provide planning and cueing assistance, and health monitoring devices.”<sup>24</sup>

In a 2000 survey entitled “American Business and Older Employees,”<sup>25</sup> the American Association of Retired Persons (AARP) found that:

- The majority of American businesses are not yet preparing for an older workforce.
- Older workers are still generally viewed by American businesses as lacking the ability to learn and to understand new technologies, and as not being flexible enough when asked to perform different tasks.

To remain productive, older workers will need accessible technology and training to keep marketable skills up to date. A major new survey of workplace technology needs concludes: “In developing solutions and accommodations for the workforce, employers need to consider a comprehensive strategy that includes training policies, technology procurement policies, accommodations, ergonomics, and healthy computing practices.

By implementing a strategy for accessible technology, employers will be better equipped to recruit and retain productive and dedicated employees, regardless of age, while empowering all employees to realize their full potential.”<sup>26</sup>

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<sup>20</sup> “Back to Work: Expectations and Realizations of Work after Retirement,” by Nicholas Maestas, Rand Corporation, October 2004 at: [http://www.rand.org/pubs/working\\_papers/2004/RAND\\_WR196.pdf](http://www.rand.org/pubs/working_papers/2004/RAND_WR196.pdf)

<sup>21</sup> “Shifting Workplace Demographics and Delayed Retirement,” Microsoft Accessibility, at: <http://www.microsoft.com/enable/aging/demographics.aspx>

<sup>22</sup> According to Bureau of Labor Statistics (BLS) data, a growing number of older workers are remaining in the workforce. After decades of decline, the labor force participation rate for those over 65 leveled off in the mid-1980s and has since been increasing. Moreover, the participation rate for those at or just above the so-called “conventional” retirement age—ages 65 to 69— has also increased. U.S. Bureau of Labor Statistics, *Employment and Earnings, January 1986 to January 2004*, Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics.

<sup>23</sup> National Bureau of Economic Research, “Impact of Technological Change on Older Workers,” May 2001

<sup>24</sup> “Technology for Adaptive Aging,” Board on Behavioral, Cognitive, and Sensory Sciences and Education of the National Academies of Science, 2004, page 2

<sup>25</sup> William D. Novelli, American Association of Retired Persons, “How Aging Boomers Will Impact American Business,” dated February 2002, accessed 07/11/03 at <http://www.aarp.org/leadership-ceo/Articles/a2003-01-03-agingboomer.html>

<sup>26</sup> “Shifting Workplace Demographics and Delayed Retirement,” Microsoft Accessibility, at: <http://www.microsoft.com/enable/aging/demographics.aspx>

MIT's AgeLab Director Coughlin adds "Perhaps the greatest reality of an older workplace will be the need for continuing education technology that will enable the older worker to acquire new skills."<sup>27</sup> The NAS report adds "How developers present on-line instruction has implications for older learners, and how older adults currently use technology has implications for their technology-related learning needs. Developers need to ensure that learning technology for older adults takes account of the learners' changing abilities and preferences, as well as individual differences that increase with age."<sup>28</sup> Research points out that performance speed varies between older and younger workers, and since speed is related to productivity, the older worker is at a disadvantage. Leading experts in human performance suggest, however, that technology can be designed to compensate for performance speed.<sup>29</sup>

## **Healthcare**

A measure of the utility and value of healthcare technology is the degree to which an aging population remains an engaged, healthy, and contributing part of the community, the society, and the economy. Another important consideration is the potential for technology to affect the cost of, quality of, and accessibility to healthcare. For example, the Veterans Administration's (VA) Chief Consultant for Care Coordination points out that a 2003 study found that technology intervention cut the healthcare needs of all VA patients by one-third.<sup>30</sup>

The VA healthcare system is in a unique position to preview how the Boomer wave might impact Americans because demographic trends of aging veterans precede the demographic trends of the nation. Today, 9.3 million veterans are age 65 years or over. Forty per cent of veterans who use VA medical facilities are elderly. In addition, VA is the caregiver to 75,000 nursing home and long-term care residents.

All of its programs have substantial portfolios focused on aging-related research, and its rehabilitation-related research is directly tied to technological developments and therapeutic advances which improve the functioning and independence of older veterans. The VA healthcare system would provide an effective test bed for healthcare technology related to the aging population at large.

Three areas of healthcare technologies that deserve special mention are: detection/prevention, wellness/monitoring, and "healthcare unbound."

## **Detection and Prevention**

The two leading causes of decline in an aging person's quality of life are disease and disability. New technologies are being developed for early detection which include: assessing neuromuscular skeletal function through gait and motion monitoring; quantitative

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<sup>27</sup> "Technology Needs of Aging Boomers," Joseph Coughlin, PhD, *Issues in Science and Technology*, MIT, Fall 1999

<sup>28</sup> "Technology for Adaptive Aging," Board on Behavioral, Cognitive, and Sensory Sciences and Education of the National Academies of Science, 2004, page 3

<sup>29</sup> N. Charness and K. W. Schaie, "Impact of Technology on Successful Aging," Springer Series Societal Impact on Aging, 2003, p. 39

<sup>30</sup> From an interview with Dr. Adam Darkins, Chief Consultant for Care Coordination, Veterans Health Administration

tools for assessment of depression, changes in activities of daily living, cognitive decline and dementia; quantitative image analysis for dermatology; pathogen detection for wound care; and, allergen and toxin measurement for keeping the home environment healthy.

Sensors can also detect falls, the leading cause of injury in the elderly, and automatically alert medical providers and caregivers to the problem. According to the Chairman of CAST, Eric Dishman, who is also the General Manager for Consumer health Platforms at Intel and is one of the leading proponents for directing corporate attention to the technology needs of an aging population, and is also an expert in the use of sensors for detection:

As more biological and behavioral sensors find their way into the home, we have the opportunity to study the unfolding of disease processes in ways never before imagined. Mobile, embedded, wearable, and even implantable technologies can help to establish personal baselines—typical sleep patterns, eating habits, body temperature, and blood pressure. Home-based sensor and diagnostic technologies could help establish "disease signatures" that show up physiologically and behaviorally before more severe symptoms become readily apparent. For example, sensor networks combined with an intelligent inference engine might someday not only detect dementia's onset earlier but also perhaps analyze its type according to a complex calculus of the nature of memory loss, social behaviors, and changes in personal routines.<sup>31</sup>

For prevention, promising new technology applications include: decision guidance systems; language-based medication compliance; evidence or outcomes based informatics; home based and mobile technology to support social networks and communications; dynamic rehabilitation; personal health status informatics; and electronic health records.

In a ten-year study documented in *Successful Aging*, Jack Rowe and Robert Kahn found that lifestyle choices and behaviors have a greater influence on how we age than any other factor, including genetics.<sup>32</sup> How technology can contribute to positive lifestyle choices and behaviors becomes, then, as important to wellness and prevention as to effective healthcare.

## **Wellness and Monitoring**

It is in remote monitoring that aging technologies converge with what is commonly known as telemedicine or telehealth. The Veterans Administration (VA) has one of the largest remote monitoring programs in the nation, currently providing in-home services to more than 5,000 veterans. By introducing relatively inexpensive technology products in homes, VA nurses can monitor 150 patients at a time<sup>33</sup>. Research reveals a resistance by some to being monitored as they view it as decreasing their autonomy and privacy. On the other hand, VA found that most aging persons are excited about the technology and caregivers see it decreasing stress and demands on their time and health. Examples include:

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<sup>31</sup> "Inventing Wellness Systems for Aging in Place," Eric Dishman, Intel Corp. in *Computer*, IEEE, May, 2004

<sup>32</sup> Jack Rowe and Robert Kahn, *Successful Aging: The MacArthur Foundation Study of Aging in America*, New York: Pantheon Books, 1998.

<sup>33</sup> From an August, 2005 interview with Dr. Adam Darkins, Chief Telemedicine Consultant, Veterans Health Administration

- ADT Security Services ([www.adt.com](http://www.adt.com)) just started selling the QuietCare security system for \$199 plus \$79.95 a month. It provides at-home monitoring through five small wireless motion sensors and sends alerts when there may be a problem. A second product, Companion Services, costs \$199 plus \$10 a month and provides a “personal help button” that the senior wears as a pendant or wristband; pushing the button alerts ADT to send help.
- GE Security ([www.ge.com](http://www.ge.com)) has similar products called Home Assurance and Personal Emergency Response that also use motion sensors to monitor whether seniors are engaging in their regular activities at home and provide a call button in case of emergency.
- Wheels of Zeus, started by Apple Computer co-founder Steve Wozniak has developed a GPS location system which “uses lightweight Smart-Tags that can be attached to clothing and other items. Smart-Tags communicate with other easy-to-operate [components](#) to monitor elderly individuals, particularly those impaired by Alzheimer’s disease or other forms of dementia, and who may be prone to wandering into dangerous areas.”<sup>34</sup>

In their report on the “Technology for Adaptive Aging” discussed earlier, the National Academies of Science cautioned that while data generated by remote monitoring can be transformational, it also creates a significant challenge: “It is essential to develop the software needed to transform the huge amounts of data generated by these systems into information useful to healthcare workers, caregivers, and clients. New technology must be developed in ways that avoid information overload, provide useful outputs, and respond to ethical, acceptability, and liability concerns, especially those related to privacy.”<sup>35</sup>

## Healthcare Unbound

Forrester Research, one of the world’s leading market and consumer research firms, suggests a new model it calls “Healthcare Unbound”<sup>36</sup> in which technology products are worn (“on”), embedded (“in”), and placed in the person’s environment (“around”). Those products depend heavily on networks, devices, and processes whose original purposes range from communication to entertainment to safety, and are especially relevant to needs of an aging population. Healthcare unbound involves technologies such as:

- **Virtual doctor's visits.** Web-enabled physician-patient consultations for routine care save money compared with in-person appointments. Inspired by Blue Shield of California and its pioneering deal with RelayHealth, payers will begin to reimburse for Web visits, spurring wider adoption by MDs.

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<sup>34</sup> For more information on WoZ, visit this Web site: <http://woz.com/2005/consumer.html>

<sup>35</sup> “Technology for Adaptive Aging,” Board on Behavioral, Cognitive, and Sensory Sciences and Education of the National Academies of Science, 2004, page 2

<sup>36</sup> From “Healthcare Unbound,” Forrester Research, December 17, 2002, at: <http://www.forrester.com/ER/Research/Brief/0,1317,15452,00.htm>



- **Portable devices.** Phillips Medical Systems' new handheld device enables family members to perform life-saving resuscitation on victims of cardiac arrest. The HeartStart Home Defibrillator was approved by the FDA in November 2002, and is available for purchase on the Web and in selected pharmacies.
- **Accident-proofing.** Today's low-tech home adaptations -- handrails in the bathtub and such -- will be joined by more products like Caldera Corporation's Dial 2000 stove. Each Caldera burner has its own timer that must be set and will turn off by itself, reducing fire risks due to memory lapses and dementia.

## Caregiving

One of the major trends in American society will be the increasingly more important role of the "caregiver." Time, energy, and commitment will be increasingly required of Boomers that must care for aging parents, school age children, and family and friends with disease or disabilities. The following statistics suggest the scope and impact of caregiving in today's society:

- 52 million informal and family caregivers provide care to someone age 20+ who is ill or disabled.<sup>37</sup>
- 25.8 million family caregivers provide personal assistance to adults (aged 18+) with a disability or chronic illness.<sup>38</sup>
- Nearly one out of every four households (24% or 22.4 million households) is involved in caregiving to persons age 50 or over.<sup>39</sup>
- Just over half of all caregivers for persons aged 50+ are employed full-time and almost two-thirds are employed either full- or part-time.<sup>40</sup>
- Caregiving costs U.S. businesses annually up to \$29 billion in lost productivity.<sup>41</sup>

Technology such as remote monitoring devices and networks, ePrescribing, eLearning about the aging parent or spouses' disease or disability, or robotic companions will assist with many caregiving tasks. MIT's Coughlin adds "Indeed, virtual caregiving networks may become crucial to delivering publicly and privately provided services such as preventative healthcare, meals and transportation."<sup>42</sup>

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<sup>37</sup> "Informal Caregiving: Compassion in Action," Department of Health and Human Services, Washington DC, June, 1998, based on data from the National Survey of Families and Households (NSFH)

<sup>38</sup> Arno, P.S., Levine, C., and Memmott, M.M. (1999), "The Economic Value of Informal Caregiving," *Health Affairs*, Vol. 18, No. 2, pp. 182-188, based on data from the National Survey of Families and Households (NSFH)

<sup>39</sup> "Family Caregiving in the U.S.: Findings From a National Survey," National Alliance for Caregiving and AARP, June 1997

<sup>40</sup> Ibid.

<sup>41</sup> "The MetLife Study of Employer Costs for Working Caregivers," Metropolitan Life Insurance Company, June 1997

<sup>42</sup> "Technology Needs of Aging Boomers," Joseph Coughlin, PhD, *Issues in Science and Technology*, MIT, Fall 1999

## **Communications**

Communications technologies help ensure the safety and independence of an aging population. Communications are equally necessary for social support (an important component of quality of life), enabling caregivers to monitor loved ones at a distance, and to support telemedicine.

The National Academies of Science report on Technology for Adaptive Aging concludes, however, that technology has not kept pace with research into communications needs and barriers of aging persons. The most common requirements are repetition, augmentation, amplification, and simplification, and especially with persons with cognitive impairment. They go on to say:

Three major barriers impede communication with and for older adults: over-accommodation to aging, word retrieval, and multitasking; each has implications for the design of communication technology for older adults. Each reflects a common source of complaints from older adults. Each has generated a considerable body of basic research. And each provides a potential access point for the application of technologies designed to enhance communication with older adults.<sup>43</sup>

The field of communications is also a good candidate for technologies resulting from brain/computer interface research. Other technologies, such as speech-to-text or text-to-speech translators would allow older persons to moderate the speed of incoming communications, and control where and when messages are received.

Specific technologies of interest include “mobile communication and computing devices” or MCCDs, which can combine features currently available in mobile telephones, personal digital assistants, and more. The challenges involved in designing MCCDs to be acceptable to and usable by aging users include training, usability, the need for adaptive interfaces, and privacy concerns.

Communications technology solutions will require cooperative work by technologists, and behavioral and social scientists as well as a “systems approach” that includes consideration of caregivers, the extended family and the community.

## **Cognition**

Cognition includes such topics as memory, spatial ability, attention, processing speed, executive functions, and text comprehension (verbal abilities such as vocabulary and reading). Cognitive decline is not inevitable. The prospect of increasing numbers of long term Alzheimers patients has gotten the attention of the medical and scientific community resulting in billions of dollars being devoted to research, and new schools of brain and cognitive science (BCS) being established.

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<sup>43</sup> “Technology for Adaptive Aging,” Board on Behavioral, Cognitive, and Sensory Sciences and Education of the National Academies of Science, 2004, page 2

To date, there have been innovations in detection and treatment as well as research and development of technologies to enhance cognitive performance, although wide scale deployment or commercialization has not yet happened. This should change as the corporate sector recognizes business opportunities.

Earlier detection and treatment of Alzheimers has become an economic as well as a medical and social priority. The public policy director for the Alzheimer's Association says "It becomes important to provide support services to delay institutional care as long as possible. If we could delay nursing-home placement of every Alzheimer's patient by one month, we could save \$1.2 billion annually."<sup>44</sup> Technologies being developed for Alzheimers include tracking the social health of early stage patients and helping them remember names and faces of friends and family. A product developed by the Georgia Institute for Technology, although designed for aging persons, has applications for anyone with diminished memory function:

The "Memory Mirror" system uses RFID (radio frequency identification) technology which is available yet expensive today. Each household item (e.g. medicine bottles, food containers) has a RFID tag on the bottom, and the designated storage area (e.g. medicine cabinet, key tray) has a RFID reader on the top. Each item is photographed and entered into the system's inventory. With this setup, the memory mirror system tracks the removal and return of each differently tagged object to and from the storage area.<sup>45</sup>

The mirror appears as a monthly calendar to the user (consumer, caregiver or medical provider), with graphic representations of the prescription bottle, family member, or task according to the date remembered.

Robotics offers the potential to assist an aging population with cognition as well as greater independence. Until now, robotics has concentrated mostly on industrial applications, but is moving toward offering an aging population companionship, assistance with daily activities, and the means to offset reduced cognitive abilities.

## **Barriers to the Development of Aging-Related Technologies**

There appear to be four major barriers to identifying and responding to needs for aging technology: awareness; access; acceptance and adoption; and use, usefulness, and usability:

### **Awareness**

As with any new product or technology, making consumers, caregivers, healthcare and aging services providers aware of its availability is a primary concern. There are, however, several sources of information on aging-related technologies. For example, the Center for Aging Services Technologies (CAST) offers a user-friendly clearinghouse for currently available technology products, pilot projects, research and development, and emerging technologies.

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<sup>44</sup> "Medical Innovation and the Aging of America," from a speech given by Deborah Thompson, Director of Public Policy of the Alzheimers Association at the Council of State Governments Forum, October 20-21, 2001, Sponsored by the Alliance for Aging Research

<sup>45</sup> For more information on the Memory Mirror, see Georgia Tech's web site at <http://www.cc.gatech.edu/fce/ec1/projects/dejaVu/mm/>

“Technology for Long Term Care” (LTC), funded by the Department of Health and Human Services, is a one-stop, Web-based source that provides information to professionals on available LTC technologies. Here, professionals can learn about low- and high-tech options currently available in six areas: fall detection and prevention, bathing, lifting and transferring, wander management, calling for assistance, and incontinence. The site also highlights key issues to consider, such as regulatory concerns and resident quality of life, before selecting a technology. Once they decide which technology will meet their needs, they can search the site’s extensive database to find specific products. A “Question for Vendors” feature provides useful questions to ask vendors and manufacturers about their products. Product information includes names, descriptions and details, price (when available), date last updated, the care issue and the category the product belongs to, and manufacturer/distributor contact information.”<sup>46</sup>

The U.S. Department of Health and Human Services’ Administration on Aging has also begun funding “Aging and Disability Resource Centers” (ADRCs) through grants to states “to help consumers to learn about and access long-term supports ranging from in-home services to nursing facility care.” These ADRCs could be useful networks for increasing awareness of technologies as well as delivering services.<sup>47</sup>

The Center for Independent Living’s “Pathfinder for Services and Programs for Older Americans,” developed as a joint project between the Rehabilitation Research Training Center on Independent Living Management (RRTC-ILM) and the Rehabilitation Engineering Research Center on Technology for Successful Aging (RERC-Tech-Aging), is a comprehensive reference manual on federal programs and legislation as well as a source of useful information and references on such topics as assistive technology, home modification, transportation, and housing.

Awareness of caregivers is as important as the awareness by aging persons of their own technology needs. Almost three in ten caregivers say they obtain information on caregiving from the Internet (29%) or a doctor (28%). Smaller percentages rely on family and friends (25%) or other healthcare professionals (10%) for their caregiving information. Many caregivers and patients seem to trust the Internet for medical information, with 36% reported as saying they are as likely to trust Web-based healthcare advice as their own doctor’s.<sup>48</sup>

## **Access**

There is good reason to believe that access to technology will become less of a barrier over time. CAST (the Center for Aging Services and Technologies), the Center for Research and Education on Aging and Technology Enhancement (CREATE) and the Rehabilitation Engineering Research Center for Successful Aging are widely promoting the importance of design for all ages and abilities, sometimes referred to as Universal Design.

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<sup>46</sup> For more information on this Web site, visit: [www.TechForLTC.org](http://www.TechForLTC.org)

<sup>47</sup> “Aging and Disability Resource Centers: A Joint Program of the Administration on Aging and Centers for Medicare and Medicaid Services – Overview,” Fact Sheet, U.S. Department of Health and Human Services’ Administration on Aging, available at [http://www.aoa.gov/press/fact/pdf/fs\\_aging\\_disability.pdf](http://www.aoa.gov/press/fact/pdf/fs_aging_disability.pdf)

<sup>48</sup> Czaja, S.J., et al., Clinical Issues in E-Health Research June, 2005 Bethesda, MD, NIA Grant P01 AG 17211-0252

CREATE states: “To make technology available to people of all ages and abilities, a challenge for the research and design community is to understand: 1) why technology is difficult to use when it is; 2) how to design technology for easier and effective use; and 3) how to effectively teach people to use and take advantage of technologies that are available.”<sup>49</sup> When, however, we expand the issue of access to include those on the other side of the “digital divide,” (e.g. poor, rural, minority, inner city, etc.) and those with disabilities, the challenges of cost and distribution are as important as design. Research is needed to better understand how such programs as Medicaid and the Assistive Technology Act can extend access to technology products that are related to aging as well as healthcare and disability.

### **Acceptance and Adoption**

MIT’s AgeLab Director - Joe Coughlin - says that more research is needed to understand why older persons do or do not accept and adopt technology. “Motivation leading to acceptance or adoption is a critical piece of the puzzle. We need much more research to trace the paths from attitudes to adoption to long-term use. What do we need to do to assure there are tech adoption rates?” In their report on “Technology for Adaptive Aging,” the National Academies of Science identified several issues that affect acceptance of technology by older persons, to include: control; autonomy; agency and dignity; culture and language; expectations and stereotyping; privacy; safety; trust; training; and usability.<sup>50</sup>

Any assessment of the technology needs of aging persons should consider each of these issues. Beyond research, the application of Universal Design principles would address the unique needs of the various stages of aging. For example, a late Boomer who is proficient with video game controllers may consider usability and ease of use differently from the oldest old who have had limited or dated experience with information or communications technology.

### **Use, Usefulness and Usability**

CREATE researchers have made a powerful case that design and training are the key elements in successful use of technology. In responding to the market’s needs, companies will need to place greater emphasis on design. There is already a great deal of research taking place at universities in how to design products for the aging. Some have suggested that the focus of design should be on “interfaces” with technology while others have found that task-irrelevant consistency (e.g. favorite icons always being in the same place on a desktop) is more important.

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49 S.J. Czaja, J. Sharit, N. Charness, A. Fisk , and W Rogers, “The Center for Research and Education on Aging and Technology Enhancement (CREATE): A program to enhance technology for older adults, *Gernotechnology*, 2001; 1(1): pp 50-59.

<sup>50</sup> “Technology for Adaptive Aging,” Board on Behavioral, Cognitive, and Sensory Sciences and Education of the National Academies of Science, 2004, page 2

There appears to be less interest, however, in integrating human factors and design for aging with classroom curricula. The University of Florida's Charness<sup>51</sup> has suggested that better design and training principles be developed for institutions preparing students for careers in aging services and aging technologies. For example, caregivers placing new technologies in the aging person's home must be concerned with training and being trained in the successful use of that product.

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<sup>51</sup> From an interview with Dr. Neil Charness in August, 2005

## Responding to Technology Needs

Universities and corporations are responding increasingly to aging demographics by organizing programs of study in gerontology and geriatrics - and undertaking research into technologies with an eye on Boomer and caregiver needs. A few universities have organized courses in “gerontechnology,”<sup>52</sup> such as the Universities of Washington, North Texas, and South Florida.

According to CAST (the Center for Aging Services Technologies), the private sector has been slower to recognize the significant opportunities that may be generated by aging demographics. Increasingly, however, small, medium, and large corporations are investigating a broad range of applications, and advanced technology products can now be found in specialized retail outlets and catalogs. There has been no attempt, to date, to survey and understand the research and development effort, size, nature, motives, and strategies of such firms.

Responding to technology needs also involves moving beyond research into the product development, testing, and evaluation stages through technology transfer and commercialization. Some university and federal programs collaborating with private sector corporations have been successful in innovating products. Given the amount of bench research taking place, however, the potential for technology transfer or commercialization is far from being realized.

Product design and development that builds on existing devices can leapfrog the full development cycle and result in products that are simply extensions of familiar gadgets. One report points out that cell phones, which are very familiar to Boomers, “are the basis for a host of ideas for future products, as well as some available now in Europe and Japan. For example, there is a cell phone that detects voice tremors, indicating a risk of Parkinson’s disease. There is also one that reminds patients to take their medications at programmed intervals and includes a built-in pill dispenser; another has navigational features to help people with memory problems find their way around town, and still others help monitor conditions like diabetes.”<sup>53</sup>

The potential for aging-related products is limited only by imagination and marketability. The latter is limited, however, to how well products respond to recognized needs.

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<sup>52</sup> Gerontechnology was developed in Europe in the 1980s and takes a broad approach to the study of technology and aging, seeking to understand multiple dimensions, including research, design, manufacture and marketing.

<sup>53</sup> “Old age in the technology age: New devices to monitor health and well-being at home – a growing new sector,” San Francisco Chronicle, August 8, 2005

## **Aging-Related Technology Research**

Government, academia and industry are responding to technology needs with a significant level of research covering a broad range of topics.

### **Federal Government**

The content, direction, and funding of federal research related to aging is scattered throughout numerous Departments and laboratories within Departments. Unlike the federal disability community's Interagency Committee for Disability Research or the Joint Working Group on Telehealth, there is no coordinating group for aging-related technology research. Highlighted here are federal departments that have significant research programs dedicated to aging and associated needs.

### **National Institutes of Health**

The National Institute on Aging, the lead agency in the Department of Health and Human Services' National Institutes of Health (NIH) for aging research, will disburse nearly \$850 million in Fiscal Year 2006 for both intramural and extramural research, and nearly \$25 million for 87 Small Business Innovation Research (SBIR) grants, and another \$3 million for Small Business Technology Transfer (STTR) grants. It is the SBIR program, and particularly Phase II, that leads to technology because of the "commercialization plan" required by NIA's omnibus solicitation.

NIA's SBIR and Small Business Technology Transfer (STTR) programs support small businesses and nonprofit research organizations that conduct research leading to the development of products and services that improve the health and well-being of older Americans. The goal is to translate research on aging, age-related medical conditions and diseases, and special problems and needs of older Americans into innovative programs, systems, networks, and other products needed by health care professionals, informal caregivers, and older Americans to maintain and/or improve their health and to maintain and/or improve their overall sense of well-being. All applicants are required to develop, implement, and test the efficacy of their products and services.

The NIA's SBIR-approved grant topics include "technology for adaptive aging," intended to move the technology discussion reported in the National Academy of Science's 2003 workshop by the same name (and referred to often in this paper) toward commercial applications. Other NIH institutes and centers solicit proposals for SBIR topics applicable to aging technology, such as the National Institute of Nursing Research and the National Institute of Arthritis and Musculoskeletal and Skin Diseases. NIH Institutes also partner with non-profit advocacy and research organizations such as the Alzheimers Association to identify and coordinate research needs for the nation's aging at risk.

NIA also funds Roybal Centers at 10 universities to "improve the health, quality of life, and productivity of middle-aged and older people through facilitating the translation from the basic behavioral and social sciences (including human factors) to practical outcomes, including new technologies, for the benefit of the aged."



The National Library of Medicine has also been active in extending information to the public through their Web site [www.nihseniorhealth.gov](http://www.nihseniorhealth.gov) which contains information on aging-related health topics, remedies, and help for caregivers.

### **Department of Education**

Another federal program actively researching technologies having aging applications is the Rehabilitation Engineering Research Centers (RERCs) funded by the Department of Education's National Institute for Disability and Rehabilitation Research (NIDRR). Because of the strong linkage between aging and disabilities, all 22 RERCs may also be considered research sites for an array of applications that respond to the needs of aging persons. RERC programs focused on aging can be found at the University of Florida (RERC on Technology for Successful Aging) and Wisconsin's Trace Center (RERCs on Universal Interface and Information Technology Access, and Telecommunications Access). The RERC for Universal Design at the University of Buffalo focuses on "smart" housing, and the RERC for Advancing Cognitive Technologies at the University of Colorado focuses on cognitive disabilities related to aging. The RERC on Workplace Accommodation at Georgia Institute of Technology also includes an aging workforce as a primary focus of its research.

### **Veterans Affairs**

The Department of Veterans Affairs (VA) represents the nation's largest network of aging related services, and is widely recognized as a leader in introducing technology for aging in place that features a home monitoring system that enables veterans to electronically send health information to their health care provider. The provider, often a nurse, can then provide the veteran with feedback and advice. In addition to monitoring, the system includes video-phones, in-home messaging devices, and personal computers with interactive chat rooms. This monitoring system has significantly reduced the number of hospital visits of participating veterans pertaining to chronic conditions. It has increased patient compliance with medications, patient satisfaction with care, and perceived quality of life.

### **Department of Transportation**

The Department of Transportation (DOT) is interested in transportation safety and human performance. It funds, for example, MIT's AgeLab to study alternatives to driving and improving performance of older drivers. For other programs, see the section on Mobility.

### **Industry**

Although data is not available on the extent of industry research and development related to aging, the technology sector is addressing the needs outlined above, and includes an array of very small to very large firms pursuing very high to very low technology.

One example of a very large firm active in research and development of aging technology applications is Intel Corporation. Intel's Proactive Health strategic research project funded in part by NIDRR is developing in-home technology prototypes to test applications that address the needs of the world's aging population.

Its use of sensor and RFID technology to track ADLs<sup>54</sup> for persons with early stage cognitive decline enables monitoring a broad range of *activities, contexts* (place, time, settings), and *variations in performance* (accommodating interruption, abandonment, interleaving, flexible tasks, group tasks, etc.). This technology allows for more extensive monitoring, and may lead to stimulating cognitive activity.

Intel's "Caregiver Assistant" is a prototype system that can make eldercare easier by detecting the activities of an elder without requiring direct observation by a caregiver. The system collects data from small, wireless, battery-less sensors called Radio Frequency Identification (RFID) tags placed on household objects. These sensors identify which objects are touched and when, then uses statistical methods to detect high-level activities

One of the smaller firms conducting R&D on lower tech items is E-Vision America of Normal, Illinois. Its "i.d. Mate" allows persons with low vision to identify products in the home and kitchen using a portable bar code reader. "Rex the Talking Pill Bottle" developed by MedivoxRx Technologies of Pittsburgh assists pharmacies by allowing the dosage instructions and other critical information to be read aloud to patients in addition to providing the instructions on the standard label.

Like other technologies, to identify and quantify the full sum of industry research and the potential for innovation, a survey of private firms would be useful.

## **Universities**

Interest among academic communities in research and innovation of technology for the aging is increasing. Whereas most research is concentrated in life sciences of aging, the following are examples of university programs addressing a broad range of technology needs:

### **Massachusetts Institute of Technology (MIT)**

"Changing Places / House\_n" is a research consortium at MIT that explores how new technologies, materials, and design strategies can better accommodate aging-in-place. A major focus is on sensor technologies that can be used by human-computer interfaces that help people stay healthy as they age. The consortium includes the MIT Media Lab and other departments at MIT, Intel Research, the Boston Medical Center, Stanford Medical, University of North Carolina School of Public Health, Bensonwood Homes, and the Center for Innovative Minimally Invasive Therapy.

One of the nation's leading centers of technology research and development for aging applications is MIT's "AgeLab" Partnering with corporations and government, AgeLab's mission is to "invent new ideas and creatively translate technologies into practical solutions that improve people's health and enable them to "do things" throughout the lifespan,"<sup>55</sup> focusing on: driving and personal mobility, wellness and

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<sup>54</sup> Activities of Daily Living ("ADLs") are a set of common daily activities which are tracked for elders in early stage cognitive decline.

<sup>55</sup> From the Web Site of the Massachusetts Institute of Technology's Age Lab at: [http://www.mit.edu/afs/athena/org/a/agelab/about\\_agelab\\_purpose.shtml](http://www.mit.edu/afs/athena/org/a/agelab/about_agelab_purpose.shtml)

self-empowered health, independent living and caregiving, and business strategy and policy innovation.<sup>56</sup>

## **Georgia Institute of Technology**

Georgia Institute of Technology's Aware Home Research Initiative "addresses challenges facing the future of domestic technologies."<sup>57</sup> Research projects include a) an "Indoor Location Service" which "integrates a variety of technologies throughout the home space, which range from relatively simple and robust low-resolution strategies, such as RFID, to more sophisticated and higher resolution, state-of-the-art computer vision solutions, b) "Activity Recognition" which includes methods to monitor the general activities of the occupants. This awareness includes low-level tasks such as reading a newspaper or watching TV, and higher-level tasks such as preparing a meal, or using a blood glucose monitor; and c) the fusion of audio and video sensors. Sponsors include Intel, Motorola, Hewlett-Packard and the National Science Foundation.

## **University of Colorado**

The Coleman Institute for Cognitive Disabilities at the University of Colorado is one of the nation's leading centers to "catalyze and integrate advances in science, engineering and technology to promote the quality of life and independent living of people with cognitive disabilities." The Institute also co-funds the Rehabilitation Engineering Research Center (RERC) for Advancing Cognitive Technologies with NIDRR.<sup>58</sup>

## **University of Florida**

Three centers at the University of Florida focus on issues of aging, disability and independence. Mentioned above, the Rehabilitation Engineering Research Center on Technology for Successful Aging, funded by NIDRR developed the Gator-Tech Smart House using principals of pervasive computing. The National Older Drivers Research and Training Center, funded by NHTSA, FHWA, CDC and the Florida Department of Transportation, conducts research on issues affecting older driver safety, including screening, assessment and rehab approaches. This Center also employs driving simulation in its research. The Center for Telehealth and Health Care Communications participated in the Veterans Administration's tele-homecare demonstrations and developed and maintains the AlzOnline website to provide support for caregivers of persons with Alzheimer's disease ([www.alzonline.net](http://www.alzonline.net)).

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<sup>56</sup> One of AgeLab's primary research areas is older drivers "by integrating human factors, cognitive psychology, gerontology, medicine, engineering and planning..." "We study and experiment with new technologies that help enhance safety behind the wheel. Other work examines the risks of health and medicine to the driving task. A major pillar of the AgeLab's research is understanding how older adults make decisions to drive and/or cease driving, including how they perceive their own driving ability and the role of families in the driving decision." This research is being funded by the U.S. Department of Transportation's University Centers Transportation Program.

<sup>57</sup> From the Web Site of Georgia Tech's Aware Initiative at: <http://www.cc.gatech.edu/fce/ahri/projects/index.html>

<sup>58</sup> From the Web Site of the University of Colorado's Coleman Institute at: <http://www.colemaninstitute.org/about.php>

## **CREATE**

As an adjunct to technology research, the “Center For Research & Education on Aging & Technology Enhancement” (CREATE), a consortium of the University of Miami, Florida State University and Georgia Institute of Technology, researches human interaction with technology. Its objective is to better understand needs, preferences, patterns of use, and problems with existing technologies, systems or products, and to design solutions to overcome barriers of acceptance and use. CREATE is one of the nation’s principal advocates for a user-centered, human factors design approach to technology for aging and is funded in part by the National Institutes of Aging.

The National Institute of Aging also funds two major networks of research centers at universities throughout the United States:

The Claude D. Pepper Older Americans Independence Centers research the decline of physical function and loss of independence at the following universities: UCLA, Duke, Harvard, Maryland, Yale, Texas, Wake Forest, Michigan, and Kansas

Edward Roybal Centers for Research at the following universities: Indiana, Princeton, Stanford, RAND, Boston, Illinois, Cornell, Western Kentucky, and the Oregon Health and Sciences University conduct research on patient management, well-being, how to forecast the effects of medical breakthroughs, the effects of policy on the medical and economic decisions made by aging persons, and new ways to use technology to measure and provide health care.

The new Roybal Center for Aging, Technology, Education and Community Health at the Oregon Health and Sciences University is focused on establishing a use-inspired living laboratory for technology-based health monitoring and support of independent aging, utilizing unique study sites in the community consisting of individual residences and communities together with advances in ubiquitous computing. This Roybal Center further aims to accelerate the process of development and translation of knowledge gained in this living laboratory through innovative public-private partnerships, cross-disciplinary collaborations and recruitment of new talent into the field. Initial pilots are addressing a breadth of key topics including prototype development of home computer monitoring systems of cognitive function, algorithmic techniques for inferring outcomes from continuous activity data and identifying monitoring needs and optimal communication channels for older people and their family.

## **Associations**

There is not currently a business, trade, or industry organization that represents the interests of companies engaged in research, development, manufacture or distribution of technology for an aging population. There are, however, numerous organizations dedicated to advocating for various issues and interests of stakeholders.

CAST (the Center for Aging Services Technologies) is a coalition of industry and advocacy organizations whose focus is to “get major technology and consumer product companies as well as universities to unleash their creative abilities to address technology development.”<sup>59</sup> CAST organizes and promotes conferences, workshops, the “Imaging Technology Pavilion” at this year’s White House Conference on Aging. CAST views demographic changes as equivalent to the concern over Y2K.

The Gerontological Society of America (GSA) is a non-profit professional organization which promotes the conduct of multi- and interdisciplinary research in aging by expanding the quantity of and improving the quality of gerontological research, and by increasing its funding resources; and to disseminate gerontological research knowledge to researchers, to practitioners, and to decision and opinion makers. GSA’s formal “Interest Group on Technology and Aging” acts as a forum for aging and technology professionals to discuss their research and practice of applying technology to meeting the needs of an aging population. These include “assistive, computer-based, distance learning, healthcare and other evolving technologies that may intersect the aging domain.”<sup>60</sup>

SPRY (Setting Priorities for Retirement Years) Foundation, established in 1991, is an independent, nonprofit foundation that carries out research and educational activities that emphasize planning and prevention-oriented strategies. SPRY’s programs focus on enabling people to better access and understand new information by translating research findings into consumer-friendly language. SPRY’s recent work emphasizes understanding and applying computer-based technology and multi generational approaches to adult learning.<sup>61</sup>

The Alzheimer’s Association describes itself as a “convener and catalyst for collaborations with investigators in industry, academia and other organizations to promote basic and applied Alzheimer research.” There are currently 4 million Americans living with Alzheimer’s, a number projected to reach 14 million by 2050.<sup>62</sup> Because of the impact of Alzheimer’s on patients, caregivers and institutions, brain and cognitive science research funding is one of their highest priorities.

The American Association of Retired Persons (AARP) is a multi-dimensional policy and advocacy organization that collaborates with numerous government, non-profit, and for profit organizations on a wide range of matter related to aging.

At this White House Conference, The National Association for Home Builders will be exhibiting its “Life/Wise Home” designed with features and technologies that support aging in place. Their research incorporates universal design principles and many of the design features and technologies discussed elsewhere in this Paper.

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<sup>59</sup> “Progress and Possibilities: State of Technology and Aging Services,” Center for Aging Services Technologies, 2003, pp. 26

<sup>60</sup> For more information on the GSA and its Technology and Aging interest group, visit their Web site at <http://faculty.cua.edu/tran/gsa-tag/background.htm>

<sup>61</sup> For more information on the SPRY Foundation, visit their Web site at: [http://www.spry.org/about\\_spry/about\\_spry.html](http://www.spry.org/about_spry/about_spry.html)

<sup>62</sup> “New Prevalence Study Suggests Dramatically Rising Numbers of People with Alzheimer’s Disease,” *Archives of Neurology*, August 18, 2003

If, as this Paper suggests, technology is increasingly important to the needs of our rapidly growing aging population, an association that represents the interests of aging-related products and services firms is clearly needed to respond to the many other stakeholders and issues discussed herein. A true industry association would also be expected to advance policies that maximize the growth, innovation, and competitiveness of aging-related technologies.

## **Partnerships**

Emphasis on leveraging resources, transferring, and commercializing technology should lead to greater interest in public/private partnerships. The following are examples of advocacy organizations that have taken the lead in organizing settings, electronic exchanges and research to promote collaboration and partnerships:

The American Association of Retired Persons (AARP), in partnership with a dozen or more corporate employers, developed an online service it calls its Workforce Initiative.

The Remodelors™ Council of the National Association of Home Builders (NAHB) in collaboration with the NAHB Research Center, NAHB Seniors Housing Council, and AARP developed the Certified Aging-In-Place Specialist (CAPS) program to address the growing number of consumers that will soon require these modifications.<sup>63</sup>

The Everyday Technologies for Alzheimer Care (ETAC) initiative is a research funding effort established in 2003 by the Alzheimer's Association and Intel Corporation. Agilent joined the partnership in 2005.

CAST promotes partnerships by providing a Web-based bulletin board “where companies, researchers and service providers can post collaboration opportunities.”<sup>64</sup>

The Alzheimer's Association also convenes a Research Roundtable, a consortium of senior science staff and thought leaders from pharmaceutical and biotech companies, and imaging equipment manufacturers to “accelerate the progress of Alzheimer research and drug discovery by identifying common challenges and sharing expertise across member organizations.”<sup>65</sup>

Oregon's Roybal Center is currently working on a major collaboration with Intel involving use of sensor and medication delivery devices to understand activities of daily living with an emphasis on contextualized medication prompting using continuous data derived from in-home assessment. This promises to advance our understanding how real world events and activities associate with successful medication use (a major healthcare challenge).

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<sup>63</sup> For more information on this program, visit the NAHB Web site at:

<http://www.nahb.org/generic.aspx?sectionID=126&genericContentID=8484>

<sup>64</sup> See “Partnering Opportunities” on the CAST Web site at: <http://www.agingtech.org/partnering.aspx>

<sup>65</sup> From the Alzheimer Association web site at: <http://www.alz.org/Research/roundtable.asp>

A few federal programs lend themselves to innovation partnerships, such as Small Business Innovation Research (SBIR), Small Business Technology Transfer Research (STTR) grants, and the National Institute of Standards and Technology's (NIST) Advanced Technology Program (ATP). NIA is currently seeking proposals for SBIR/STTR grants "within a strategic perspective that emphasizes the importance and viability of public and private-sector research collaboration."<sup>66</sup> NIST and the National Science Foundation (NSF) have also formed a partnership to encourage university researchers to utilize NIST facilities.

## **Research Approaches**

### **Requirements and needs**

It is in the process of needs assessment that research necessary to develop technology will be identified. Organizations such as MIT's AgeLab and AARP organize focus groups to identify needs. CAST has identified "technology development needs" based on a survey of aging services organizations.<sup>67</sup> The Rehabilitation Engineering Research Center on Successful Aging at the University of Florida works closely with consumers of aging-related products to identify needs as well as attitudes.<sup>68</sup> Through a combination of focus groups and surveys, these organizations have been able to create profiles of effective devices as well as to classify consumer dissatisfaction. Product developers and consumers can both benefit from their findings that could easily evolve into design and performance standards.

Because the scope of the needs of an aging population and the potential market are so large, it is important for innovators to fully and accurately understand what products would be most useful, rather than reverting to stereotypes and "ageism." One solution is to identify technology needs through good research. Rather than letting the initiative of individual investigators define the research agenda and market forces alone drive the development of product requirements, research and development should be driven by in-depth analysis and understanding of the needs, capacities, and limitations of the aging population.<sup>69</sup>

In the field of human factors engineering or user-centered design, there are well-developed methodologies that consider the user's technology needs throughout the product development process. When applied to the development of technological support for older adults, these methods include systematic observation of older adults' behavior in their working, living, and recreational environments to establish their requirements and the constraints on potential products. The methods include the interactive development and quantitative evaluation of prototype products and services during the formative stages of development. They include systems analysis studies of the larger context in which products will be introduced to look for cost-effective gains and unintended consequences.

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<sup>66</sup> Taken from the NIA RFP at: <http://grants.nih.gov/grants/guide/pa-files/pa-04-064.html>

<sup>67</sup> "Progress and Possibilities: State of Technology and Aging Services," Center for Aging Services Technologies, 2003

<sup>68</sup> For more information on Florida's approach, see RERC Director William Mann's "Smart Technology for Aging, Disability, and Independence – the State of The Science," Wiley-Interscience. 2005 (pp 20-27)

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A researcher for AARP believes the National Institute on Aging is “well positioned to support studies that bring about this multidisciplinary focus and that apply the kinds of methodologies that will ensure development of technologies that would be truly useful for an aging population. Projects could be specifically targeted for collaboration between major U.S. corporations interested in tapping into the market created by the aging population and specialists interested in development aspects of aging.”<sup>70</sup>

## A “User-Centric” Approach

Methodologies that incorporate the user and his or her technology needs from the beginning of basic research assure the usefulness of the product. One writer suggests “While the potential for improving the quality of older adults’ lives with technology is great, this potential may remain unrealized unless manufacturers and designers adhere to a user-centered approach to technology development. Optimization of interaction between older adults and new technology is dependent on designers’ understanding of the abilities of older adults.”<sup>71</sup>

CAST adds “...the traditional Aging Enterprise is in no position to take advantage of impending growth. A colossal failure of imagination prevents us from seeing our products and services from the standpoint of our customers and some of that failure can be traced to a social-service mentality: “doing good” for people rather than providing them with services they define in their own terms.”<sup>72</sup>

At the heart of the user-centric approach are the concepts of “usability,” “usefulness,” and “use.” Current interest in promoting usability as a primary goal for product design can best be described as a “movement,” where usability professionals have their own association.<sup>73</sup> Two [international standards](#) define usability and human-centered (or user-centered) design:<sup>74</sup>

- “[Usability refers to] the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of user.” - ISO 9241-11
- “Human-centered design is characterized by: the active involvement of users and a clear understanding of user and task requirements; an appropriate allocation of function between users and technology; the iteration of design solutions; multi-disciplinary design.” - ISO 13407

Usefulness is a more subjective concept, but has been identified as one of the primary factors affecting consumer purchases. To illustrate, a “grabber” (a rod with a handle on one end and a pair of pincers on the other often found in toy stores or garden shops) would not normally be considered an aging-related technology, but is useful for picking up loose items from the

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<sup>70</sup> “Silver Industries and the New Aging Enterprise,” Moody, Harry R., PhD, *Generations*, Winter 2004-05, pp. 62-63

<sup>71</sup> “Gerontechnology: Research and Practice in Technology and Aging,” David C. Burdick, PhD and Sunkyo Kwon, PhD, Springer Publishing Company, 2004, p. 42

<sup>72</sup> *opus cit.*, pp 62-63

<sup>73</sup> For information on the Usability Professionals Association, visit their Web site at: [www.upassoc.org](http://www.upassoc.org)

<sup>74</sup> Standards for user-centered design and usability are developed under the auspices of the International Organisation for Standardisation (ISO).



floor or reaching for items on a shelf. It's usability for aging persons can be improved through user-centered design. If useful and usable, its use should follow closely.

## **Universal Design and Human Factors**

Universal design is the process of creating products (devices, environments, systems, and processes) which are useful for and usable by people with the widest possible range of abilities, operating within the widest possible range of situations (environments, conditions, and circumstances), as is commercially practical. The concept of *universal design* is especially important to aging-related technology because it sidesteps the negative effects of stereotyping and ageism, just as it avoids a negative association with disabilities.

Universal design has two major components:

- Designing products so that they are flexible enough that they can be directly used (without requiring any assistive technologies or modifications) by people with the widest range of abilities and circumstances as is commercially practical given current materials, technologies, and knowledge; and
- Designing products so that they are compatible with the assistive technologies that might be used by those who cannot efficiently access and use the products directly.<sup>75</sup>

University research relating to design for aging includes such titles as human factors, ergonomics, and universal design. Some have suggested that the focus should be on "interfaces" with technology while others favor task-irrelevant consistency (e.g. favorite icons always being in the same place on a desktop). A powerful case has been made that design and training are key to successful use of technology. In responding to the market's needs, companies will need to focus on both.

The University of Wisconsin's Trace Center's Universal Design / Disability Access Program is funded by the National Science Foundation. The Department of Education funds the Rehabilitation Engineering Research Center for Universal Design at the University of Buffalo, focusing on housing design and technology and also developing "evidence based guidelines for applying universal design in practice. These guidelines will link research to design practice and help designers, builders and manufacturers increase the value of their products and environments. A second development project will produce a suite of evaluation tools for use in design development and evaluation. A third project will develop a series of exemplary universally designed products and environments with industry partners."<sup>76</sup>

The Center for Research and Education on Aging and Technology Enhancement (CREATE) and the Rehabilitation Engineering Research Center for Successful Aging are widely promoting the importance of design for all ages and abilities. CREATE describes its mission

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<sup>75</sup> "Universal Design of Consumer Products: Current Industry Practice and Perceptions," Gregg Vanderheiden, Ph.D., and Jim Tobias, from the Trace R&D Center Web site at: [http://trace.wisc.edu/docs/ud\\_consumer\\_products\\_hfes2000/](http://trace.wisc.edu/docs/ud_consumer_products_hfes2000/)

<sup>76</sup> For more information on the newly-designated RERC for Universal Design at Buffalo, visit their sister RERC's Web site at: <http://cosmos.ot.buffalo.edu/t2rerc/news/announcements.htm#udrerc>

as: “To make technology available to people of all ages and abilities, a challenge for the research and design community is to understand: 1) why technology is difficult to use when it is; 2) how to design technology for easier and effective use; and 3) how to effectively teach people to use and take advantage of technologies that are available.”<sup>77</sup> The movement toward usability referred to above should assist in reaffirming the business case for universal design.

A good example of how universal design can accommodate the needs and abilities of aging persons is Vodafone. In 2004, Vodafone commissioned an accessibility assessment which found that almost 21% of adults in the EU aged 55 or over find it difficult to use a mobile phone given the increasing promotion of smaller and compact as features that are attractive to younger consumers. In response, they launched [Vodafone Simply](#) with handsets that are larger than the latest mobile phone with bigger keypads, easy to use and plain on-screen instructions on how to use them.<sup>78</sup>

## **Converging Technologies**

The continuing convergence of different technologies offers the potential for breakthrough innovation to improve the quality of life for aging persons. The converging of telecommunications and medical devices, for example, continues to foster the emerging technology of telemedicine/telehealth. Beyond current applications, the addition of sensors, radio frequency identification (RFID), and global positioning system technologies are leading to new applications for location of persons and things, remote monitoring, and wellness. Within the next few years, RFID will be imbedded in smart home environments and will enable a new breed of “service appliances,” a device or systems that supports household or personal activity management.

One of the most promising “convergence technologies” is the combination of nano-technology, biotechnology, information technology, and brain science/cognition. In a 2002 conference on “Converging Technologies for Improving Human Performance,” visions of future applications included workshops on “Expanding human cognition and communication,” and “Improving human health and physical capabilities” with the goals of “aging with dignity and life extension” and “improving the quality of life of disabled people.” The conference ended with recommending a “national R&D priority area on converging technologies focused on enhancing human performance,”<sup>79</sup> a goal that is consistent with improving quality of life for an aging population.

## **Technology Transfer**

Until now, most research has been directed at aging life sciences. To enable technology innovation, methodologies that convert research into useful applications should be employed

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<sup>77</sup> S.J. Czaja, J. Sharit, N. Charness, A. Fisk, and W Rogers, “The Center for Research and Education on Aging and Technology Enhancement (CREATE): A program to enhance technology for older adults, *Gernotechnology*, 2001; 1(1): pp 50-59.

<sup>78</sup> For more information on Vodafone’s products for aging and disabled persons, see their Web site at: [http://www.vodafone.com/article/0,3029,CATEGORY\\_ID%253D3040602%2526LANGUAGE\\_ID%253D0%2526CONTENT\\_ID%253D266200,00.html?](http://www.vodafone.com/article/0,3029,CATEGORY_ID%253D3040602%2526LANGUAGE_ID%253D0%2526CONTENT_ID%253D266200,00.html?)

<sup>79</sup> “Converging Technologies for Improving Human Performance,” a NSF/Department of Commerce report from a 2001 workshop by the same title, published by the World Technology Evaluation Center, June 2002

from the beginning. Such methodologies would incorporate a standard industry system or product development life cycle methodologies that have been so successful in the past.

Technology transfer from bench science to useful product has been a common goal of university and federal laboratories using instruments such as Cooperative Research and Development Agreements (CRADAs) and Small Business Innovation Research (SBIR) grants. NIH, for example, transfers millions of dollars of technology using hundreds of CRADAs each year. Education's NIDRR funds an RERC at the University of Buffalo that focuses on technology transfer.

Further analysis would be useful for identifying best university and government technology transfer practices, and the need for more or different policy or financial incentives.

## **Primary Drivers of Innovation**

Understanding what will motivate government, universities, and technology firms to undertake and invest in research, development, and technology innovation is key to public policy analysis. Eric Dishman, Chairman of CAST<sup>80</sup> and others suggest a looming crisis if government, academia, and industry do not now respond to technology needs for aging Boomers. Because the first wave of Boomers has yet to retire, however, a sense of urgency or crisis has not yet surfaced.

Needs and requirements will be clearly defined by seniors and caregivers in laboratories and research settings that encourage innovation. Increasing multidisciplinary research linking schools of public health, university/private sector partnerships will result in tech licensing, small company spin-offs, consulting, and contract research.

Bi-directional education on technology innovation and provider services between the consumer, managers, families, caregivers, funding sources, and legislators will be needed. Universities and corporations will redefine, research, prototype, design, evaluate, produce, and market products and systems that have universal functionality that enables the home to interface with the health care system.

Having living laboratories where technology models are tested – both products and systems, and having providers understand the technology's impact will be important. Housing providers and the Veterans Administration offer good examples with their Continuing Care Retirement Communities (CCRC's), where all levels of care are available on one campus.

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<sup>80</sup> Dishman founded the Center for Aging Services Technologies (CAST) as a vehicle for the “collaboration of technology companies, aging services providers, university researchers, government representatives, and business interests...to revolutionize the way we care for our aging population.”<sup>80</sup> CAST has become the voice for innovation in the arena of technology for aging persons, and views the primary barrier to innovation “as much an imagination problem as a technology problem.”

## Investment

The assumptions and attitudes of investors play an important role in financing and driving innovation, product development and marketing. Like most financial decisions, investment, whether private or public, is based on expected returns to the investor. Whereas the universe of individuals and organizations having an interest in a technology is practically unlimited, there are relatively few investors evaluating potential returns on aging-related innovations for the following reasons: the “market” is unknown and changing; there is limited differentiation with the disabilities market; and the term “aging” is often associated with negative stereotypes. Moreover, there is no popular business model (with the possible exception of “anti-aging” products), although CAST has a Task Group on “Future Business and Economic Model for Aging Services” that should help. The enthusiasm generated by technology applications in settings such as the White House Conference on Aging should help convince upper management that a longer-term strategy for developing aging-related technology makes good business sense based on the potential of Boomer (and older) markets.

Venture capital (VC) investor North Castle Partners LLC (NCP), which describes itself as “the leading private equity firm focused exclusively on consumer businesses dedicated to Healthy Living & Aging,”<sup>81</sup> estimates the U.S. healthy living and aging market at \$400 billion and projects that to grow to \$1 trillion by the year 2020. Some generalizations on VC attitudes toward investing can be drawn from a MIT research paper on VC attitudes toward the long-term care industry. The authors surveyed VC firms and found that “the most attractive [innovations] to investors are those which are covered by private insurance or are an affordable out-of-pocket expense to consumers. They will be those that can scale, can be protected by patents, help individuals maintain independence in the face of increasing frailty or help families cope with caring for aging loved ones. Examples include systems and services that assist with compliance, medications, management of chronic conditions from the home, or products that help adult children extend their parents’ independence.”<sup>82</sup>

It seems likely that investment by federal, state and local government will be directed toward technology procurement for specifically mandated populations such as veterans, Native Americans, military, Medicaid and Medicare. The Veterans Administration has taken the lead with its acquisition, deployment and evaluation of a multi-year remote monitoring home healthcare program (discussed above). Early returns show reduced healthcare costs, improved health, and high levels of patient and provider satisfaction. These and other more limited pilot or demonstration programs will likely represent the extent of public procurement until an acceptable return on investment can be clearly demonstrated and additional funding can be identified.

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<sup>81</sup> For information on North Castle, visit their Web site at: <http://www.northcastlepartners.com/hla/market.php>

<sup>82</sup> “What Venture Capitalists Think of Long-Term Care And Why it Matters,” Joseph Coughlin, PhD and Bryan E. Preston, M.B.A., M.P.A., MIT AgeLab, 2005

Investing in innovation faces other risks or barriers that have yet to be evaluated, such as the following:

- An untested market unique in size and characteristics
- Perceptions of legal liability among product developers
- Technology that may change more rapidly than aging consumers can adapt to it
- Lengthy and expensive clinical testing
- Limited coordination of R&D among various stakeholders
- Intellectual property issues such as inter-company collaboration
- A market fragmented by individual state medical regulation and legal liability laws
- Government intervention (e.g. changing or lagging policies on reimbursement and regulation)
- Competition from government (e.g. federal product innovations and patents, limiting marketing agreements or distribution, etc.)
- Lack of appropriate tools and data to evaluate return on investment

## **Incentives**

Other than unproven market and profit potential, there are currently no significant policy or profit incentives for innovators and product developers. Depending on the products, incentives may also need to be directed at the medical provider (to prescribe or recommend), the caregiver, and the consumer (to demand) before product developers will take notice, a “chicken or egg” dilemma.

While organizations cannot be forced to innovate, government policies, regulations and standards can be powerful incentives. For example, the Americans with Disabilities Act of 1990 mandated accessible transportation, accessible information, and accessible employment. Scientists, engineers, and technology pioneers responded with innovations in many applications such as accessible software, computer peripherals, “smart” housing, and other assistive technologies. Legislation extended to the aging population may have a similar impact.

Other possible incentives are directly related to barriers. For example, whereas the length and cost of the Food and Drug Administration (FDA) approval process can act as a disincentive, short cuts to the regulatory process, subsidized or government-sponsored clinical testing, or limits to product or medical liability may be viewed positively by innovators and investors. FDA and the aging-related industry should also open a dialogue on what definitions and criteria would be applied to determine the latter’s need to regulate.

## Primary Barriers to Innovation

While positive drivers for innovation such as investment and incentives are limited, negative “barriers” to innovation and product development are numerous. Those frequently mentioned are:

### Ageism and Stereotyping

Technology firms are hesitant to identify themselves with aging products because of stereotypes and the fear that they will alienate traditional, younger market segments. Current stereotypes that appear in television sitcoms, for example, portray aging persons as dodderly, eccentric, quaint, or incapacitated in some amusing or patronizing way. To some extent, this treatment of seniors in the media is a manifestation of longstanding stereotypes. On the other hand, sensitizing young product designers to both the special needs and significant market potential of older consumers may be a useful undertaking for industry associations and product design institutes. CAST has found bringing together young engineers from technology companies and care staff that serve older populations is an excellent mechanism to help each group better understand and cooperate on needed developments.

In the housing industry, builders and developers tend to offer basic home designs without consideration of the buyers physical and cognitive needs, though some builders are beginning to offer technology for aging needs as options. The National Association of Home Builders is taking the lead with its Seniors Housing Council and conferences such as its annual “Building for Boomers & Beyond: Seniors Housing Symposium,” where builders and technology innovators meet.

Another adage long associated with aging is “You can’t teach an old dog new tricks.” Research suggests that the opposite may be true...that undertaking new activities, even in advanced years, is good for one’s physical, emotional and cognitive health. An article in the Product Development and Management Association’s trade journal that promotes the aging population as a dynamic and important market states “While research has shown that seniors learn in a different manner from those who are younger, they can and do learn, taking college courses, enrolling in exercise programs, and playing a significant role in their communities. All of these foster self-confidence and mental acuity that belie common stereotypes and myths. Such seniors are open to new ideas and new products and services designed to do a better job of meeting their needs.”<sup>83</sup>

Other myths are that aches, pains and disabilities are due to aging, and not other, more controllable factors such as at-risk behaviors, environment, and lifestyle. Once these stereotypes are recognized as myths, progress can be made by innovating and applying technology to address the problems. Dispelling myths and stereotypes is a worthy role for a partnership of public and private sector stakeholders.

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<sup>83</sup> “NPD Viewpoint: Time to Stake Your Claim in the “Old” Rush?” Laurence P. Feldman, Ph.D, in the Product Development and Management Association’s *Visions* magazine, October 2001

## **Few Standards**

Like other emerging technologies, few standards, benchmarks, and validating measures exist for technology products associated with aging. Consensus or voluntary industry standards may be needed to assure: ease of use and usefulness; interoperability of products, systems and networks; interface with other technologies such as IT and healthcare; and performance according to manufacturer claims, user expectations, and needs. Widely-accepted standards will also assist product innovators in moving their innovations to the marketplace more quickly.

There are a few standards that can serve as examples, however. In 1991, uniform methods for testing and measuring wheelchair specifications and performance were developed following 10 years of research by the American National Standards Institute (ANSI) and the Rehabilitation Engineering Society of North America (RESNA). As a result, large-scale users such as the Veterans Administration can make purchasing decisions based on testing (and not marketing), and overall wheelchair safety and usability are enhanced.

Another important example is the American Society of Testing and Measurement's (ASTM) "Continuity of Care Record" (CCR) standard for electronic medical records. Several large and important "sponsors" participated in the CCR's development, including the American Academy of Family Physicians, the American Medical Association, the American Academy of Pediatrics, the Massachusetts Medical Society, the Patient Safety Institute, and Health Information Management Systems Society (HIMSS), among others. Many practicing nurses, physicians, other health care providers and technology companies collaborated on its core content. Examples such as the CCR will become increasingly important to aging patients as electronic medical records multiply, become portable, and acquire the capability of doing more than record data. The importance of CCR became evident in the wake of Hurricane Katrina with the widespread loss of paper records, many belonging to aging patients with long medical histories.

Only non-profit organizations are permitted to be sponsors of ASTM standards, but the Commerce Department's National Institute for Standards and Technology and an organization like CAST could be instrumental in initiating standards development with ASTM, ANSI or other standards development organizations on behalf of industry needs.

## **Lack of Data**

Another key gap is the lack of knowledge about what technology applications may be beneficial and cost effective in most situations. If the best methods to improve health outcomes are unknown, creating supportive tools would be unlikely. Funding additional research to identify technology outcomes is needed. Data on technology innovation, investment, and the state of the aging products and services industry would also be useful to policy-makers and other stakeholders. Clinical trials and other longitudinal studies (to include cost effectiveness or cost-benefit analysis) would be the most practical and acceptable means to generate outcomes data and analysis. The cost of such studies may be prohibitive to innovative but under-capitalized, smaller firms. Veterans Affairs, however, provides an unique environment or "test bed" for hosting such studies.

Within the National Institutes of Health (NIH), there has not, until now, been a formal requirement for or method to systematically collect data on outcomes from aging-related research funded through the SBIR/STTR programs. Although some areas of NIH have instituted a new Technet system where grantees will be required to report outcomes (to include patents, commercialization, etc.), NIA has not been included. More and better data may depend on greater coordination among federal agencies and programs, universities, providers, payers and corporations.

In an ideal world, consumer and caregiver information needs for identifying helpful technologies and funding would be assisted by a variety of sources to include local information and referral programs, caregiver ombudsmen, caregiver registries, joint purchasing cooperatives, and care management services. It is important that aging research and outcomes data be made “business ready,” i.e. in a format that technologists can use to understand consumer and caregiver requirements. The National Library of Medicine’s [www.clinicaltrials.gov](http://www.clinicaltrials.gov) demonstrates how technology can be used to satisfy important data needs for a variety of stakeholders.



## Technology Outlook

The near and long term outlook for innovative responses to technology needs of an aging population has been discussed in various settings over the past few years. The Center for Aging Services Technologies (CAST) has been actively seeking out opportunities to broadcast its message of the importance of technology as a response to the coming “crisis” implied by aging demographics. As noted above, universities such as MIT, Georgia Institute of Technology, the University of Rochester’s Center for Future Health, and the University of Florida, as well as advocacy groups such as the Centers for Independent Living have been actively promoting “smart home” technology and “proactive” independent interfaces with the nation’s healthcare system. Other advocacy groups have been actively promoting the concept of “universal design” to begin incorporating into the design and functionality of products and services that can address the needs and demands of aging users.

Many would agree that the outlook for technology cannot be clearly predicted until consumer demand is better understood. What is clear, however, is the aging Boomer consumer will dramatically change the technology marketplace. CAST will premier a video at the White House Conference on Aging that advances their vision for this marketplace, and is intended to assist public and private stakeholders to better understand the level of commitment needed to respond effectively.

## The Marketplace of the Future

These and other discussions are focusing attention on “aging in place” and “independent living.” The nearly universal appeal of these and similar concepts suggests both a large market segment and a marketplace very different from what business and industry have experienced to date. As Kemper and Mettler (2002) note, “Today’s first wave of Baby Boomers heralds the coming ranks of the new consumer. Making up almost half of the U.S. population, graying consumers have the college education, the cash, the computer experience, and the heightened expectations to make significant demands upon the health care system of the 21<sup>st</sup> century.”<sup>84</sup>

Given the prospect for longer life spans and healthier lifestyles, a product development and marketing approach to address these needs would focus on “quality of life” rather than disease and disability. Discussion about aging-related technology under this scenario would be redefined as technologies to enhance every American’s quality of life. This approach in addressing the needs of the aging Baby Boomer consumer would be consistent with the trend toward “universal design.” “Ageless, life-enhancing” marketing would then focus on an individual’s active, healthful, and productive capacity throughout his or her lifespan.

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<sup>84</sup> Donald W. Kemper and Molly Mettler, “The Age Wave: Knowledgeable and Demanding and Very, Very Large,” *Managed Care Quarterly*, Vol. 10, No. 3, p. 52-54, (Summer 2002)

Product development in the future will be consumer- and provider-driven, with innovators continually responding to new medical knowledge and consumer needs with innovative products. With healthcare's transformation into an “anytime, anywhere” business, major companies should be expected to move in for a piece of the extended market. Drug firms, device firms, health plans, and hospitals would compete for alliances with these newcomers, to bundle products and services into packages that deliver total healthcare. The following examples of what the future might bring are taken from a study conducted by Forrester Research on aging-related technology newcomers:<sup>85</sup>

- Home Director, Inc. markets software programs that network home electronics and appliances that provide for multiple-device connectivity, personal safety, and energy efficiency. ADT and General Electric will also be major players here.
- Intel's long-standing home care initiatives - its Proactive Health Research for Future Elders, for instance - will pay off in the ubiquitous use of chips in the domestic management of patients with dementia, cardiovascular disease, and cancer.
- Modeling done in a special Microsoft Home in Redmond by the firm's Consumer Prototyping and Strategy team will position that company to be a force in healthcare.
- Motorola's handsets will keep healthcare unbound mobile. On the strength of its work with the Smart Phone project of the University of Florida's Research Center on Technology for Successful Aging, Motorola will lead in introducing wireless applications for seniors with memory impairment. First up: reminders to take meds and lock the doors, and global positioning systems to aid with directions. Motorola will give away the software for free, as a public service -- but will sell the handsets for a profit.
- Home Depot will be a category killer for healthcare do-it-yourselfers. Residential repairs and improvements amount to \$180 billion a year, of which individual homeowners spend a cool \$135 billion. Today, Home Depot positions itself as a supplier for additions and alterations that accommodate growing families. But spending is already rising faster on replacements and retrofits for people with no kids in the house. Look to Home Depot to help fuel the market by whetting consumer appetites for kitchen and bath remodeling around health and safety.

Moving back the average age of onset for certain diseases promises a robust market opportunity for businesses selling products and services designed for prevention, risk reduction, and behavioral change.

Boomers will likely be more willing to pay directly for technology and producers will likely market directly to those consumers and caregivers. Other consumers, accustomed to having their health expenses reimbursed, may resist greater individual responsibility. To avoid becoming dependent themselves on coverage decisions by third party payers such as Medicare and Medicaid, marketing and advertising by technology firms will feature universal design, cost savings, and healthy, independent lifestyles to reach the widest possible market.

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<sup>85</sup> Forrester – Healthcare Unbound

Business models that increase profitability will become widespread. One venture capital firm has already concluded that “the healthy living & aging revolution is still young, and many of these businesses are experiencing strong relative growth which is forecasted to continue. In addition, they operate in highly fragmented industries and often are undercapitalized, presenting attractive opportunities to build market-leading companies. This combination of growth and fragmentation provides an extraordinary marketplace for significant shareholder value creation through leveraged buyouts, growth capital infusions, and strategic acquisitions.”<sup>86</sup>

## Caregivers

Caregivers will emerge as a major market segment for technology products. Like parents who purchase products for their children, children will provide care products for their aging parents and other seniors. This trend will be true even if the care recipient is institutionalized as product firms market directly to caregivers. Caregivers will also advocate for quality of life care and technology, and will demand information from medical providers and the government on disease, disabilities, and other requirements. Caregivers are interested in having easily accessible social and technical support for responsibilities they must perform.

Technology to monitor the health state of patients can assist caregivers by enhancing their efficiency and efficacy as well as enhancing their social networks. Up-to-date information about care, treatment and prevention, and assistance in communicating with the caregiver’s network (such as doctors, case workers, housekeepers, insurance, and banks) will be demanded. Enabling distant caregivers to play an active role in care for their loved ones is another important application for remote monitoring and telehealth technology. Education of caregivers and creation of caregiver resources will be needed - a need for which the term “caregiver informatics” was coined.

The most quickly and widely adopted products are those that are intuitive and have been proven to dramatically improve quality of life for consumers and caregivers, and improve productivity and reduce costs for providers. Products will be simple to understand and operate, and will easily integrate with the consumer’s lifestyle.

On the other hand, many caregivers have a fear of using technology; are concerned about its expense, confused by poorly engineered user interfaces, and are put off when systems suffer from problems of reliability. Acceptance of caregiver support by the medical community is important to effective aging in place. Many caregivers lack sufficient knowledge about prevention and maintenance in health care as well as knowledge of what can make him or herself more effective. A severe information gap exists where there is no or inadequate systematic training available to family and other unpaid caregivers.

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<sup>86</sup> “A growing marketplace ripe with opportunity,” North Castle Partners, a major venture-capital fund controlling a billion and a half dollars of investment funds concentrated exclusively on emerging companies in the field of healthy living and aging, from their Web site at [www.northcastlepartners.com](http://www.northcastlepartners.com)

The needs of caregivers will drive additional demand for innovative products and services to reduce burnout, support team-based care giving, teach ways to recognize and mitigate stress, provide tools for reminding and coaching in their duties, mediate disputes with elders or other caregivers, facilitate participatory decision-making, and support community involvement. This education should also include increasing employer and public awareness of the caregivers' burden also must be developed to help advance caregiver initiatives.

Changing the way long-term care is financed will be required to make caregiving more affordable. Such a system could include a mix of subsidized insurance, private insurance, tax credits, and deductions. Greater consumer choice may include stipends to family caregivers who choose to provide the care themselves and Social Security credits to those who leave the workplace to carry out full-time caregiving.

## **Disease and Disability**

The linkage among disease, disability and dependence as a natural consequence of aging will likely begin to lessen. To preserve their independence and assert their control, consumers will embrace services, products, and technologies that attack the cause and effect relationships between age and disease, disease and disability, and disability and dependence.

Links like these have already begun to weaken. According to Forrester Research,

Once a disease or condition hits, multiple opportunities will exist to manage - and diminish - its disabling impacts on physical activity, mental alertness, and emotional balance. Wearable computers, for example, will help consumers neutralize the effects of cognitive impairment, the leading cause of nursing home stays, by displaying reminders about everyday tasks on the screen of their wrist watches or the lens of their eyeglasses.

Even after disability sets in, technology in, on, and around the body will reduce its effects on activities of daily living like shopping and light housework. The share of disabled people who use assistive equipment increased from 76% in 1984 to more than 90% in 1999. Sign of more things to come: Inventor Dean Kamen's IBOT Mobility System, developed for Independence Technology, a Johnson & Johnson company, seats people comfortably and climbs stairs. Disabled users remain disabled -- but are no longer dependent.<sup>87</sup>

The challenge is significant, however. The Census Bureau Population (2001), reported the findings of data collected from the Survey of Income and Program Participation (SIPP), which revealed that 19.7% of the US population, nearly 52.6 million people have a limitation in a functional activity or social role. Of this population, slightly more than 33 million people are classified as having a severe disability. The data further shows that *disability* and *severe disability* rates increase with age as shown in the chart below:

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<sup>87</sup> "Healthcare Unbound," by Michael J. Barret *et. al.*, Forrester Research, at: <http://www.forrester.com/ER/Research/Brief/0,1317,15452,00.html>

Age Group (for entire population)	Percentage with a disability (all severities)
Less than 15 years	7.8%
15-24 years	10.7%
25-44 years	13.4%
45-54 years	22.6%
55-64 years	35.7%
65-69 years	44.9%
80+ years	73.6%

As the absolute numbers of individuals within the older age ranges increase, the number of persons with disease and disabilities will also increase significantly, even if the relative percentages decrease. Assistive technology firms will be challenged, then, to respond to the characteristics of both the disability and aging.

Diseases will be managed everywhere, all the time, and by individuals. Improved technology at lower prices will quicken a trend toward care delivered in the least restrictive and least expensive environment (usually at home). Individuals will be connected to their medical providers and healthcare networks by home nurse visits, telemedicine monitoring, patient diaries, wearable monitoring, and outpatient electronic medical records. Patients will be actively engaged in their own disease management which will become second nature.

Easy-to-use, home-based proactive health care support will be capable of assisting in early detection of health problems, and support proactive efforts by the user to remain healthy. Such a system would be knowledgeable about the user's usual state of wellness (i.e., be able to use individual data as a normative baseline), be affordable and useable by a wide array of socio-economic and ethnic groups. The system must also allow for shared decision-making with physicians and caregivers when desired.

Multiple systems will be integrated in real time to provide data trending to assist early and timely intervention in health problems. Companies will develop modular, scalable, interoperable products and platforms yielding consumer health care products that are smaller, more mobile, networked, powerful, and with new capabilities.

Medication compliance will be linked to electronic medical records. Smart pillboxes from companies like InforMedix and APREX will dispense the right medicine, in the right dose, at the right time, and finally connect through the patient's home network to enter the transaction into an electronic record that both patient and doctor can access.

Health maintenance tools will extend the productivity of scarce nurses. The Veterans Administration, building on its pilot programs in Florida, will undertake a massive rollout of in-home messaging devices that plug into regular home phone lines. The unit will turn on each morning, beep for attention, and ask the patient clinically relevant questions. If the answers indicate problems - or if there is no answer - the case manager at the other end of the line will dispatch a visiting nurse.

## **Aging in Place**

Aging in Place will become a common lifestyle reference. Home and mobile systems will interface with the health care system for prevention, early detection, and disease management. Leading centers such as Georgia Tech's Aware Home and the University of Rochester's Smart Medical Home will continually refine systems which can sense trouble, or if the patient fails to respond to a speakerphone query, alert a sequence of providers, caregivers, and EMT units.

Health care providers envision a seamless, convenient, plug & play technology for connecting health care to the home allowing them to focus on patient care while technology does the rest. Technology such as “electronic clipboards” and portable electronic medical records will also decrease provider time spent in history-taking to allow more time for patient teaching or discussion. In recognition of these new demands and opportunities, federal, state and local governments should give home broadband connectivity and wireless telecommunications infrastructure a higher priority on the political agenda.

Remote monitoring and sensors will keep track of frail elders living alone or loved ones with dementia. Commercially available products may include Precision Dynamics Corporation's microchips embedded in lightweight wrist bands, Applied Digital Solutions' FDA-approved biosensor pellet implanted in the patient's upper arm, and location-based sensor systems. Wireless technology, integrated electronic medical records, and cell phones will support continuous monitoring in home settings.

Remote monitoring will be attractive to policy-makers and third party insurers for its potential to reduce healthcare costs. Decreased need for visiting nurses or emergency room visits, lower cost, and reduced inconvenience and risks of patient travel to providers for routine exams and consultations will be promoted as significant cost savings, but these cost savings may, in part, be offset by additional staffing to monitor patients and the processing and storage required for large amounts of data generated by continuous monitoring. Remote connectivity will also require significant investment in IT infrastructure by institutional health care systems and third party payers, many of which are already struggling with the high costs of technology.

## **International**

Thus far in this Paper we have discussed aging demographics in the U.S. The issue is even more pressing for other developed nations as shown in the following table comparing demographic changes of six major industrialized countries with the U.S.:

## Rapidly Aging Populations of Major Industrialized Nations

(Population over age 65 as a percentage of total population)

	1985	1995	2000	2005	2025	2050
Japan	10.3	14.6	17.1	19.2	26.7	31.8
Italy	12.7	16.8	18.2	22.6	26.1	34.9
Germany	14.5	15.0	16.4	17.8	23.4	28.4
Sweden	17.9	17.6	17.2	17.6	22.5	27.0
France	12.5	15.0	15.9	16.7	21.7	25.5
U.K.	15.1	15.9	16.0	16.4	21.2	24.9
United States	11.8	12.5	12.5	12.6	18.8	21.7

Source: United Nations, *Replacement Migration* (New York: United Nations, 2001), 8, Table 2 and 112-143, Appendix. Projections for 2005, 2025 and 2050 are based on the UN's medium-variant projections. For Sweden, two additional sources were used: United Nations, *The Sex and Age Distribution of World Population* (1998); and Council of Europe, *Social Cohesion and Quality of Life* (2001).

A 2001 report by the Commerce Department noted “By 2050, the number of persons (worldwide) aged 60 years or older is projected to grow to almost 2 billion, when the population of older persons will be larger than the number of children (0-14 years) for the first time in human history. Fifty-four percent, the largest share of the world’s older persons, live in Asia. Europe has the next largest share, with 24 percent.”<sup>88</sup>

The Center for Strategic and International Studies, in its *Global Aging Initiative*, reports that the new major economic superpower, “China, the world’s most populous nation, faces a period of rapid aging that will outpace the aging of most of the world’s populations. Between 2010 and 2040, the proportion of people aged 65 and older will rise from 7 percent to 25 percent. This grand demographic change poses difficult questions about how to provide and sustain an adequate retirement income and a minimum level of health care for the elderly, who will number more than 332 million in 2050”<sup>89</sup>

These figures present a practically unlimited opportunity for technology firms targeting export markets. These same countries see the same opportunity, however, and “Elder tech devices have already taken off in Europe and Japan, where the populations are older than in the United States, technologies like cell phones are more advanced and the health care system is sometimes willing to foot the bill.”<sup>90</sup> While this statement does not imply the United States is behind, any comparison or discussion of competitiveness is precluded by the lack of data. Data on either production or trade of technologies and applications that are intended for aging end users are not available. Even if governments had the interest to collect such data, the industry has not been defined and products have not been classified to allow for data collection.

<sup>88</sup> “An Aging World 2001,” by Kevin Kinsella and Victoria A. Velkoff, U.S. Department of Commerce, Economic Statistics Administration, U.S. Census Bureau, DP/2264, March 2002  
<http://www.census.gov/prod/2001pubs/p95-01-1.pdf#search='An%20Aging%20World'>

<sup>89</sup> “Aging China,” by Robert Stowe England, Center for Strategic and International Studies Report. Praeger/CSIS, 2005

<sup>90</sup> “Old age in the technology age: New devices to monitor health and well-being at home a growing new sector,” *San Francisco Chronicle*, August 8, 2005

There is, however, some anecdotal information on what other countries are doing.

“Japan’s preoccupation with consumer robots is largely driven by economic imperatives. It has an aging population, declining birthrates and a looming labor shortage. Equally important, Korea and China are undermining Japan’s traditional industries, especially consumer electronics and household appliances. Japanese companies are under severe pressure to develop new products.”<sup>91</sup>

For example, Japan has also created the I-pot, an Internet-connected tea kettle that acts as a safety check for elders living alone. Created by electronics-maker Zojirushi, Fujitsu Corp. and phone giant NTT, it notifies a relative or neighbor what time seniors make their tea -- skipping that daily routine would be a sign of a problem. Japan, a leader in robotics for factories, is considered a good test bed for service robots for seniors to help with mobility and other issues, although such robots are not yet in commercial use.<sup>92</sup>

South Korea’s Samsung Advanced Institute of Technology User Interface technologies apply the five senses (sight, hearing, smell, taste, and touch) to the computer to achieve a variety of human responses. HCI technology applies sight and hearing senses, and biological signal processing technology applies senses of smell, touch and taste. These technologies will be expanded to humans using remote diagnosis and sensor technologies. Wearable input devices are in the development stage that will enable the convenient user interface.

In Europe, there is support from the European Commission for reimbursing aging-related technologies. Confronted by a rapidly aging population and soaring health care costs, for example, the Netherlands’ government set aside subsidies last year to stimulate innovations in the health sector.

Israel’s Center for Assistive Technology and Aging (GeronTech) is a non-profit organization established in 1998 as a joint venture of ESHEL - The Association for the Planning & Development of Services for the Aged in Israel and MJHS - The Metropolitan Jewish Health System, in New York.<sup>93</sup>

Because aging-related technology has not been considered an “industry” or an important or separate class of products and services until now, the case for American competitiveness has yet to be made. To do so would require recognition by both public and private sectors of its potential demand, outlook, and significance. Unlike other emerging technologies such as nanotechnology and biotechnology, aging-related technology may not yet have the level of popular appeal or a mobilized advocacy needed to capture government or industry attention.

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<sup>91</sup> “Japan’s Robot Developers Go Linux,” *Tech/News World*, August 11, 2005, see: <http://www.technewsworld.com/story/32281.html>

<sup>92</sup> ibid.

<sup>93</sup> For more information on GeronTech, visit their Web site at: <http://www.gerontech.org.il/textversion/002.html>



## Primary Market Barriers

Although the outlook for innovation and investment seems positive, significant barriers may impede the market potential. The major barriers described below also figure into discussion of assistive and healthcare technology, and it would be advantageous for stakeholders in each technology community to pursue solutions together.

### Reimbursement

The biggest cost issue is who will pay for aging-related technology. As Forrester's Boehm noted in a report, Americans expect someone else - an insurer or Medicare - to pick up the tab for preventive care like immunizations and routine exams - and rarely make impulse health care purchases. On the other hand, she says, consumers have shown they're willing to pay for treatments like acupuncture and chiropractic even when they're not covered by insurance - once they are convinced those solutions work.

There is some indication that Boomers may be more willing than previous generations to share purchases of technology with payers. In a series of focus groups with people age 50-65, the Center for Aging Services Technologies (CAST) found that most participants would be willing to pay \$50 each month for electronic monitoring technologies such as medication reminders to enable their aging parents and themselves to live independently in the community. About half of the participants said they would pay \$100 per month. In addition, participants were extremely interested in owning a device that maintained their medical records and provided them with control over this information.<sup>94</sup>

Medicare has, until now, not considered coverage of home healthcare technologies that do not include a "face-to-face" encounter with a medical provider. Recently, however, Medicare has begun funding several pilot projects to experiment with new approaches to care, such as Health Buddy, a "telemedicine" device that asks patients with chronic conditions like diabetes about their health and transmits the data to a health care provider. Forrester's Boehm predicts that telemedicine solutions to manage chronic diseases and post-hospitalization issues will prove so cost-effective that insurers and Medicare will start to cover them within the next few years, partially due to the pressure from advocacy groups like AARP. Once that happens, she wrote, "It will take only two to three years from the onset of coverage for cost-conscious consumers and aggressive providers to pounce on newly subsidized services - and purchase the devices that enable them. That should expand the market quickly."<sup>95</sup>

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<sup>94</sup> "Boomers Willing to Pay for Technology That Allows Parents, Selves More Independent Living" from a CAST press release, July 11, 2005 at <http://www.agingtech.org/documents/071105FocusGroupRelease.doc>

<sup>95</sup> "Old age in the technology age: New devices to monitor health and well-being at home - a growing new sector," San Francisco Chronicle, August 8, 2005

It can also be said that the patchwork of current and potential funding streams impede the efficiencies and cost effectiveness promised by interoperable products, networks, and systems. The scope and diversity of third party payers as well as federal, state and local government aging assistance programs make for a very complex and inefficient marketplace to the point of becoming a disincentive for innovation, investment, and marketing.

## **Privacy**

The widespread application of remote monitoring, sensors, global positioning systems, and electronic medical records gives rise to issues of privacy and security. For these technologies to provide the full benefit for independent living and disease management, information must be collected and interpreted. Fortunately, much of the debate over policies and processes to protect privacy has already taken place and has been embodied in the Health Insurance Portability and Accountability Act of 1996 (HIPAA) which spells out the privacy rights of individuals and the responsibilities of healthcare information users. Applications of these technologies, such as remote monitoring and electronic medical records, may not have been envisioned at the time of the HIPAA debate, and will need to be addressed further. The fragmented system of federal and state privacy and security policies further complicates HIPAA compliance.

## **Regulation**

A similar patchwork of federal, state and local policies, regulations, standards and codes also impacts the technology sector's response to the needs of an aging population. For example, federal, state and local regulation of nursing homes and assisted living facilities suggests that technology firms must understand, conform to, and comply with several layers of regulations and codes that differ by state, county, and municipality. The cost of understanding, conforming and complying will be passed along to an already costly healthcare system. An example of this regulatory landscape is that some states regulate against the use of wireless devices in assisted living and nursing home facilities. Another example is the set of definitions that the Food and Drug Administration applies to regulate devices that may not be well understood by innovators. Procurement policies and regulations may act as yet another obstacle to small- and medium-sized firms that do not have the financial depth for long regulatory processes.

## Conclusion

We have examined within this White Paper a broad range of issues, barriers and responses relating to technology for an aging population. While settings such as the White House Conference on Aging facilitate useful discussion, a structured analysis of technology needs, barriers, and solutions at the national level that engages the broad range of stakeholders as well as public policy-makers and corporate planners is necessary to better understand and choose among research, innovation, and investment alternatives.

The current business model for aging persons largely revolves around institutionalization in hospitals and nursing homes. While there will be a continuing need for such institutions and especially as the population of the oldest old (85 and above) increases, the value proposition for following generations will be greater independence and quality of life. A model that is designed and marketed for an improved quality of life and greater independence through “aging in place” will have much broader appeal to the evolving values and pocketbooks of the Baby Boomer consumers and their caregivers. This “quality of life” model also de-links aging from disease and disability in favor of competing values like independence, privacy, productivity, and mobility.

Technology is an important component of the quality of life model, whether it is IT, healthcare, mobility, housing, communication, or another of many other sectors. Acceptance and use will depend on evidence that applications improve quality of life, prolong independence, and comply with performance standards and user expectations. There is some evidence to believe that Boomers will be willing to pay for their own technology products if these criteria are met. Not enough is currently known about aging Boomer consumers to determine whether a likely business model will feature self-pay, third party reimbursement, or some other form of revenue. Lack of efficient and appropriate revenue or reimbursement models may be discouraging early investment in research and development. Misaligned incentives in the nation’s healthcare system can also make prevention, wellness, and home health systems (all contributing to quality of life) a hard sell.

The outlook is largely positive, however, as government, academic and business partners increasingly recognize the importance of technology for meeting aging-related needs and increasingly respond with innovative products. There also appears to be time enough to address those needs before America’s society and economy experience the full impact of our aging demographics. It is incumbent, then, upon the broadest range of stakeholders to create “partnerships” - whether they include public/private, producer/ consumer, consumer/payer, healthcare/disability/aging, or numerous other combinations - continue to convene, discuss, and advance policies and strategies that support an aging population with the best technology possible.